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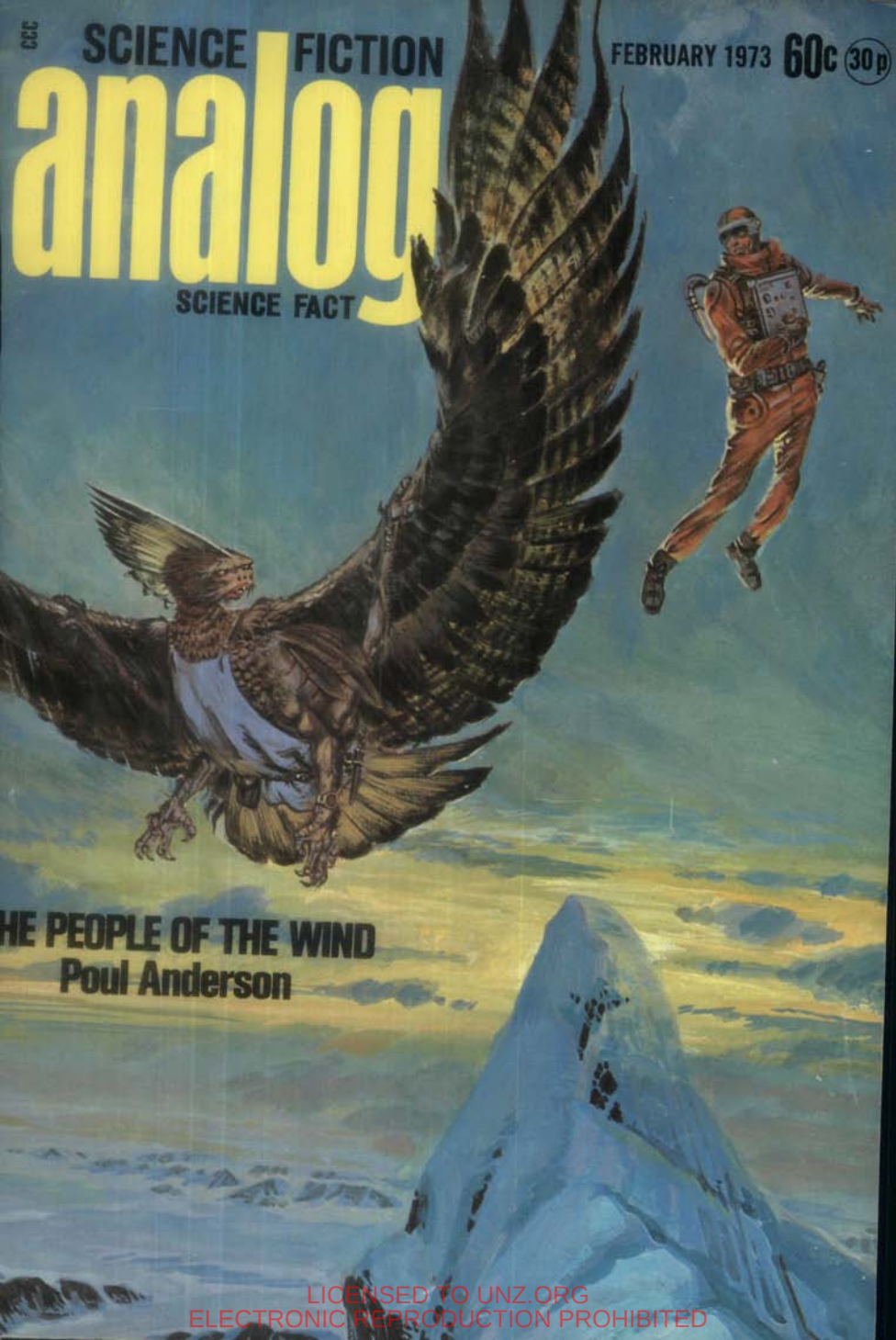

HE PEOPLE OF THE WIND
Poul Anderson

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GUEST EDITORIAL

beyond the citizen

by R. G. Cleveland

Tribesman, Barbarian, Citizen. John Campbell first defined these stages of cultural evolution in the May 1961 editorial. Since then, the definitions have been greatly refined, and we'll go into them in some detail. However, the last part of the original editorial needs repeating. It states: ". . . At each stage of cultural evolution, the preceding stage appears loathsome--and the succeeding stage appears to partake of those same loathsome characteristics . . . It's highly probable that the next stage of cultural evolution will appear, to us, to be barbarism . . . and be a . . . loathsome system indeed.

"We can't, of course, guess just what form of loathsome corruption of our selves, our dignity, looms before us. It doesn't really matter; we're going to get it anyway, whether from outside, or from our own . . . inescapable evolution.

"But we won't like it. Any more than a Tribesman likes becoming a Barbarian. Or a Barbarian likes becoming that sniveling thing, a Citizen."

So we might name a fourth stage that seems, but isn't actually, barbaric: "Parabarb." John was right; the Parabarbs are here, and Citizens do, indeed, see them as disgusting, lawless Barbarians. Before we discuss Parabarbs, though, we need a detailed discussion of Tribesmen, Barbarians, and Citizens, which we will undertake in that order.

There has been little discussion of the Tribesman in our society; yet his effect is profound. He is a creature of the state, with little sense of separate identity. "State," though, need not mean a government. Any organization with rules that relieve its members of the need for making their own decisions fills the bill. The Tribesman seeks a situation where "everything that is not compulsory is forbidden"; where he has pure ritual and taboo to guide his actions. Rulebooks and lawbooks can provide such guidelines just as well as Tribal traditions. Most high-level cultures abound in niches where these guidelines exist.

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The Tribesman is a natural by-the-book bureaucrat. His sense of security comes from following the rules with absolute strictness. Governments and other large organizations are full of such men, and dealing with them can be incredibly frustrating. They *really* go "by the book." No Tribal loan executive will approve a loan with 9,999 dollars' worth of collateral if the book says the loan needs 10,000 dollars. (And the Tribesman will be baffled when his non-Tribal superiors castigate him for this. He was only trying to follow the rules! While his superiors will be equally baffled by the fool's stubborn stupidity; his inability to see that rules are guidelines for the decision-making process, not inflexible go-no-go standards.) Nor can any Tribesman be convinced this is wrong. In fact, he will feel mild contempt for non-Tribal superiors who don't understand the *need* for following the rules with absolute strictness!

The sluggishness of giant organizations, like governments, comes mostly from the Tribesmen in their bureaucracies. Ultimate rigidity in the bureaucracy is their goal, to maintain the integrity of the tribal traditions (rules and procedures). It seems paradoxical for a Tribesman to be an empire-builder. Enlarging one's bureau (tribe) is change, and change is evil. Right? Yes . . . but obviously, large changes are more evil than small ones. Change cannot be completely blocked, but a Tribesman-bureaucrat can acquire the power to incorporate procedures (rituals) to accommodate new rules and procedures (rituals and taboos) with a minimum disturbance of the old. This isn't ideal, of course. Ideally, "someone who came up from the ranks and understands the situation" should acquire the final authority . . . a fellow Tribesman, who understands the evil of change. This rarely happens. However, the Tribesmen still manage to make it hard for anyone to streamline their beloved bureaucratic procedures very much.

This problem has no obvious solution. Giant organizations cannot function on individual judgment; they're too complex. Nor can anything stop a Tribesman from treating a rulebook as an inflexible system of ritual and taboo. Theoretically, the Tribesmen-bureaucrats could be replaced by computers, which are easily reprogrammable when change is needed (impossible with the Tribesman). Unfortunately, we have no cheap, reliable computers that are nearly capable enough. Until we do . . . which may be a long time . . . even Tribal humans will remain far more practical.

In fact, the Tribesman is the *only* human fitted for some jobs. As a natural routineer, he is ideal for tasks that would drive anyone else straight up the wall. Many neces-

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sary jobs require following the same basic procedures, day after day with little change, and Tribesmen are needed to fill them. What is lacking is a method of keeping the Tribesmen from perpetuating their rituals and taboos beyond usefulness.

This may seem like enslaving the Tribesmen. It isn't. Tribesmen do *not want* freedom of decision. They are happy only when told what and what not to do, desperately unhappy if forced to decide themselves. (That you and I wouldn't like the situation is irrelevant.) A Tribesman who starts resenting orders has ceased being a Tribesman. By definition. He has become something else entirely, and requires different handling.

The other niche for Tribesmen in a high-level culture is in the military. (Since their classic occupation of peasant farmer is of little value.) This is a giant organization of somewhat different type. The Tribesman-recruit is the delight of his sergeant in Basic Training. Once out of Basic, which governs his life minute to minute, he makes an excellent desk soldier, in any capacity of a routine nature. He's a lousy combat soldier, however. Actual combat requires application of learned techniques in unpredictable situations — in short, instant decision-making, of which the Tribesman is totally incapable. Tribal-type combat soldiers rarely survive their first real battle.

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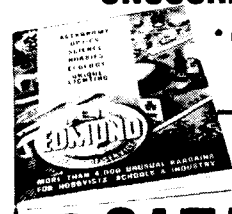

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But if only Tribesmen are fit for such jobs, such jobs are also the only ones Tribesmen can do. There are few things more disastrous, for the Tribesman personally or for his employers, than forcing him into a position where his decisions cannot be guided by ritual and taboo. As long as he has these guidelines for his life, the Tribesman can be both productive and content.

Of course, there are also Tribeswomen.

Tribeswomen-bureaucrats, of whom there are many, need no further discussion. Everything we have said about Tribesmen-bureaucrats applies to them as well. The Tribal wife and mother, however, is different. She takes her husband as her source of ritual, taboo, and the solution to all problems. She *wants* to be ruled by her "male chauvinist pig"; in no other way can she be happy. Women's libbers note, though: *only* Tribeswomen feel this way. The woman who resents male domination is no more a Tribeswoman than the man who resents taking orders is a Tribesman. The mere fact of such resentment proves they are both something else, and they require a different life style.

In fact, such Tribesmen have probably become Barbarians—the opposite end of the personality scale. Instead of being bound by traditions, laws, and rules, the Barbarian is highly individualistic and completely lawless by nature. The obvious conclusion, though, is totally wrong. The Barbarian is not necessarily a lawbreaker in a civil culture. However, he feels no obligation to obey a law made by others, simply because it is The Law. ("People make the laws, by electing the lawmakers," is meaningless to a Barbarian. Only voters *en masse* affect elections; no individual voter can. A Barbarian is a pure individual, not a member of a faceless throng; he has no sense of having a say in legislation through voting.) He will readily break the law, *if* he can gain by it. If he can't, he may be perfectly "law-abiding" . . . on the surface. Citizen and Barbarian will both take risks for personal gain; but the Citizen is morally bound not to consider illegal ventures. The Barbarian considers illegal ventures from a risk-versus-gain viewpoint, like any others.

This indicates a need for effective law enforcement. However, that, by itself, can be a sure road to disaster for any culture. No amount of force, killing, and armed police will save an oppressive culture from destruction by its Barbarians, who *have* to "live free." (Right-wing extremists note!) Temporary respites won by such methods only lead to bloodier smashups. The human animal cannot reliably be controlled by fear. Fear breeds, not respect for its object, but hate. Instilling fear in other men is sheer suicide, for this is the most de-

continued on page 173

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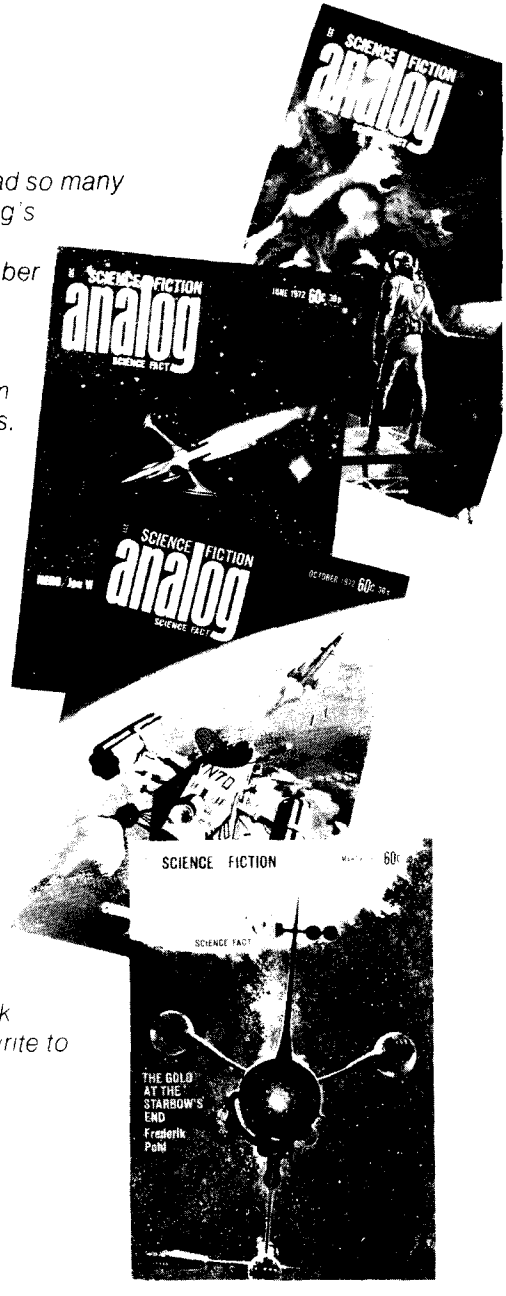

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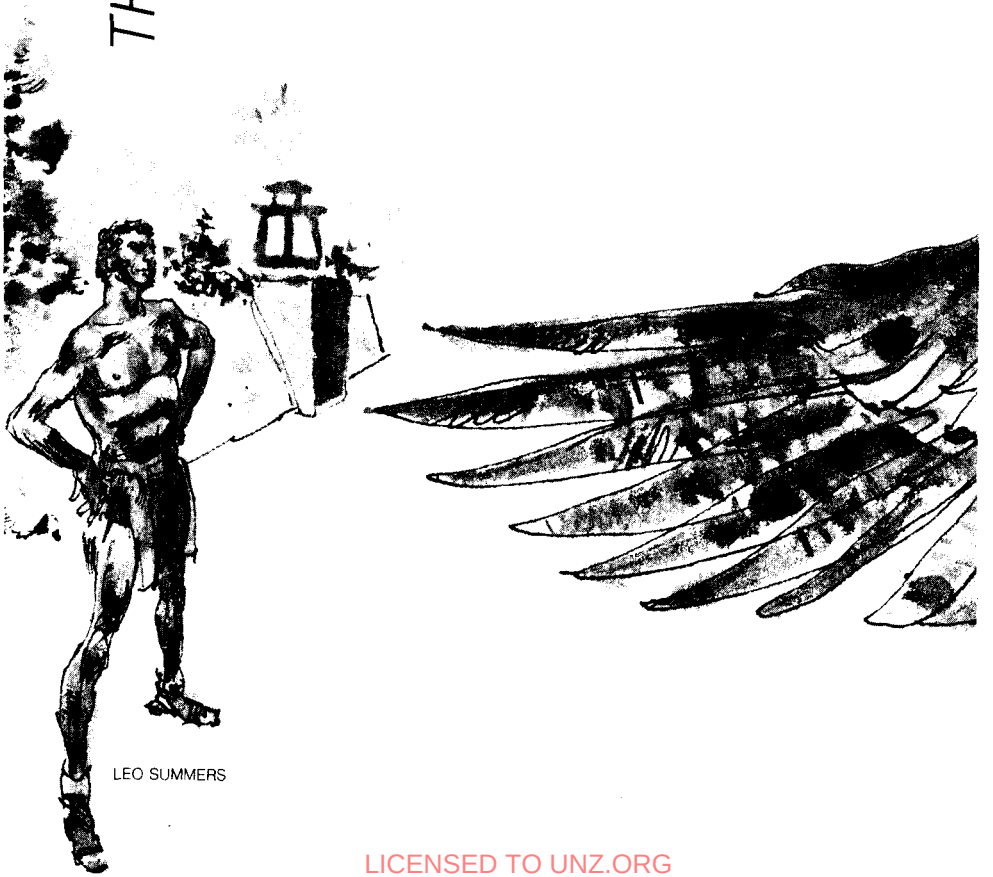
THE PEOPLE OF THE WIND

Part one of three parts. The history of human civilization is the history of conflicts between nations, societies, races. Can human beings build a viable society with nonhuman partners? And what happens to the youngsters who want to adopt alien ways, and desire to be something that they physically cannot be?

POUL ANDERSON



LEO SUMMERS

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I

"You can't leave now," Daniel Holm told his son. "Any day we may be at war. We may already be."

"That's just why I have to go," the young man answered. "They're calling Khruaths about it around the curve of the planet. Where else should I fare than to my choth?"

When he spoke thus, more than his wording became bird. The very accent changed. He was no longer using the Planha-influenced Anglic of Avalon—pure vowels, r's trilled, m's and n's and ng's almost hummed, speech deepened and slowed and strongly cadenced; rather, it was as if he were trying to translate for a human listener the thought of an Ythrian brain.

The man whose image occupied the phone screen did not retort, "You might consider staying with your own family," as once he would have. Instead Daniel Holm nodded, and said quietly, "I see. You're not Chris now, you're Arinnian," and all at once looked old.

That wrenched at the young man. He reached forth, but his fingers were stopped by the screen. "I'm always Chris, Dad," he blurted. "It's only that I'm Arinnian too. And—and, well, if war comes, the choths will need to be prepared for it, won't they? I'm going to help—shouldn't be gone long, really."

"Sure. Good voyage."

"Give Mother and everybody my love."

"Why not call her yourself?"

"Well, uh, I do have to hurry . . . and it's not as if this were anything unusual, my heading off to the mountains, and—oh—"

"Sure," said Daniel Holm. "I'll tell them. And you give my regards to your mates." The Second Marchwarden of the Lauran System blanked off.

Arinnian turned from the instrument. For a moment he winced and bit his lip. He hated hurting people who cared about him. But why couldn't they understand? Their kind called it "going bird," being received into a choth, as if in some fashion those who did were renouncing the race that begot them. He couldn't count how many hours he had tried to make his parents—make any number of ortho-humans—see that he was widening and purifying his humanity.

A bit of dialogue ran through memory: "Dad, look, two species can't inhabit the same globe for generations without pretty deep mutual consequences. Why do you go sky-hunting? Why does Ferune serve wine at his table? And those're the most superficial symptoms."

"I know that much. Credit me with some fair-mindedness, hm-m-m? Thing is, you're making a quantum jump."

"Because I'm to be a member of Stormgate? Listen, the choths have

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been accepting humans for the past hundred years."

"Not in such flocks as lately. And my son wasn't one of them. I'd've liked to see you carry on our traditions."

"Who says I won't?"

"To start with, you'll not be under human law any more, you'll be under choth law and custom . . . hold on. That's fine, if you're an Ythrian. Chris, you haven't got the chromosomes. Those who've pretended they did, never fitted well into either race, ever again."

Damnation, I'm not pretending.

Arinnian thrust the scene from him as if it were a physical thing. He was grateful for the prosaic necessities of preparation. To reach Ythran's aerie before dark, he must start soon. Of course, a car would cover the distance in less than an hour; but who wanted to be caged in metal and plastic?

He was nude. More and more, those who lived like him were tending to discard clothes altogether and use skin paint for dress-up. But everybody sometimes needed garments. An Ythrian, too, was seldom without a belt and pouch. This trip would get chilly, and he lacked feathers. He crossed the tiny apartment to fetch coverall and boots.

Passing, he glanced at the desk whereon lay papers of his work and, in a heap, the texts and references he was currently employing, printouts from Library Central. *Blast!* he thought. *I loathe quitting when I've nearly seen how to prove that theorem.*

In mathematics he could soar. He often imagined that then his mind knew the same clean ecstasy an Ythrian, aloft alone, must know in the flesh. Thus he had been willing to accept the compromise which reconciled him and his father. He would continue his studies, maintain his goal of becoming a professional mathematician. To this end, he would accept some financial help, though he would no longer be expected to live at home. The rest of what little income he required he would earn himself, as herdsman and hunter when he went off to be among the Ythrians.

Daniel Holm had growled, through the hint of a grin, "You own a good mind, son. I didn't want to see it go to waste. At the same time, it's too good. If it weren't for your birding, you'd be so netted in your books, when you aren't drawing a picture or writing a poem, you'd never get any exercise; at last your bottom would grow fast to your chair, and you'd hardly notice. I s'pose I should feel a little grateful to your friends for making their kind of athlete out of you."

"My chothmates," Arinnian corrected him. He had just been given his new name and was full of glory and earnestness. That was four years ago; today he could smile at

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himself. The guv'nor had not been altogether wrong.

Thus at thirty—Avalonian reckoning—Christopher Holm was tall, slender, but wide-shouldered. In features as well as build, he took after his mother: long head, narrow face, thin nose and lips, blue eyes, mahogany hair (worn short in the style of those who do much gravbelt flying) and as yet not enough beard to be worth anything except regular applications of antigrowth enzyme. His complexion, naturally fair, was darkened by exposure. Laura, a G5 star, has only 72 percent the luminosity of Sol and less ultraviolet light in proportion; but Avalon, orbiting at a mean distance of 0.81 astronomical unit in a period of 0.724 Terran, gets 10 percent more total irradiation than man evolved under.

He made the customary part-by-part inspection of his unit before he put arms through straps and secured buckle at waist. The twin cone-pointed cylinders on his back had better have fully charged accumulators and fully operating circuits. If not, he was dead. One Ythrian couldn't hold back a human from toppling out of the sky. A couple of times, several together had effected a rescue; but those were herders, carrying lassos which they could cast around their comrade and pull on without getting in each other's way. You dared not count on such luck. O God, to have real wings!

He donned a leather helmet and lowered the goggles which were his poor substitute for a nictitating membrane. He sheathed knife and slugthrower at his hips. There would be nothing of danger—no chance of a duel being provoked, since a Khruath was peace-holy—not that deathpride quarrels ever happened often—but the Stormgate folk were mostly hunters and didn't leave their tools behind. He had no need to carry provisions. Those would be supplied from the family stores, to which he contributed his regular share, and ferried to the rendezvous on a gravsled.

Going out the door, he found himself on ground level. Humans had ample room on Avalon—about ten million of them; four million Ythrians—and even here in Gray, the planet's closest approximation to a real city, they built low and widespread. A couple of highrises sufficed for resident or visiting ornithoids.

Arinnian flicked controls. Negaforce thrust him gently, swiftly upward. Leveling off, he spent a minute savoring the view.

The town sprawled across hills green with trees and susin, color-patched with gardens, that ringed Falkayn Bay. Upon the water skimmed boats; being for pleasure, they were principally sail-driven hydrofoils. A few cargo vessels, long shapes of functional grace, lay at the docks, loaded and unloaded

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by assorted robots. One was coming in, from Brendan's Islands to judge by the course, and one was standing out to the Hesperian Sea, which flared silver where the sun struck it and, elsewhere, ran sapphire till it purpled on northern and southern horizons.

Laura hung low in the empty west, deeper aureate than at midday. The sky was a slowly darkening blue; streaks of high cirrus clouds, which Arinnian thought of as breastfeathers, promised fair weather would continue. A salt breeze whispered and cooled his cheeks.

Air traffic was scant. Several Ythrians passed by, wings gleaming bronze and amber. A couple of humans made beltflights like Arinnian's distant; they were hardly to be told from a flock of slim leathery draculas which evening had drawn out of some cave. More humans rode in cars, horizontal raindrops that flung back the light with inanimate fierceness. Two or three vans lumbered along and an intercontinental liner was settling toward the airport. But Gray was never wildly busy.

High up, however, paced shapes that had not been seen here since the end of the Troubles: warcraft on patrol.

War against the Terran Empire—shivering, Arinnian lined out eastward inland.

Already he could see his destination, far off beyond the coastal range and the central valley, like a cloudbank on worldedge, those peaks which were the highest in Corona, on all Avalon if you didn't count Oronesia. Men called them the Andromedas, but in his Anglic Arinnian had also taken to using the Planha name, Weathermother.

Ranchland rolled beneath him. Here around Gray, the mainly Ythrian settlements northward merged with the mainly human south; both ecologies blended with Avalon's own, and the country became a checkerboard. Man's grainfields, ripening as summer waned, lay tawny amidst huge green pastures where Ythrians grazed their maukh and mayaw. Stands of timberwood, oak or pine, windnest or hammerbranch, encroached on nearly treeless reaches of berylline native susin where you might still glimpse an occasional barysauroid. The rush of his passage blew away fretfulness. Let the Empire attack the Domain . . . if it dared! Meanwhile he, Arinnian, was bound for Eyath—for his whole choth, of course, and oneness with it, but chiefly he would see Eyath again.

Across the dignity of the dining hall, a look passed between them. *Shall we wander outside and be ourselves?* She asked permission to take leave of her father Lythran and her mother Blawsa; although she was their dependent, that was mere ritual, yet rituals mattered greatly. In like fashion Arinnian

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told the younger persons among whom he was benched that he had the wish of being unaccompanied. He and Eyath left side by side. It caused no break in the slow, silence-punctuated conversation wherein everyone else took part. Their closeness went back to their childhood and was fully accepted.

The compound stood on a plateau of Mount Farview. At the middle lifted the old stone tower which housed the senior members of the family and their children. Lower wooden structures, on whose sod roofs bloomed amberdragon and starbells, were for the unwed and for retainers and their kin. Further down a slope lay sheds, barns, and mews. The whole could not be seen at once from the ground, because Ythrian trees grew among the buildings: braidbark, copperwood, gaunt lightningrod, jewelleaf which sheened beneath the moon and by day would shimmer iridescent. The flowerbeds held natives, more highly evolved than anything from offplanet—sweet small janie, pungent livewell, graceful trefoil and Buddha's cup, a harp vine which the breeze brought ever so faintly to singing. Otherwise the night was quiet and, at this altitude, cold. Breath smoked white.

Eyath spread her wings. They were more slender than average, though spanning close to six meters. This naturally forced her to rest on hands and tail. "Br-r-r!" she laughed. "Hoarfrost. Let's lift." In a crack and whirl of air, she rose.

"You forgot," he called. "I've taken off my belt."

She settled on a platform built near the top of a copperwood. Ythrians made few redundant noises; obviously he could climb. He thought she overrated his skill, merely because he was better at it than she. A misstep in that murky foliage could bring a nasty fall. But he couldn't refuse the implicit challenge and keep her respect. He gripped a branch, chinned himself up, and groped and rustled his way.

Ahead, he heard her murmur to the uhoth which had fluttered along behind her. It brought down game with admirable efficiency, but he felt she made too much fuss over it. Well, no denying she was husband-high. He didn't quite like admitting that to himself. *(Why?* he wondered fleetingly.)

When he reached the platform, he saw her at rest on feet and alatans, the uhoth on her right wrist while her left hand stroked it. Morgana, almost full, stood dazzling white over the eastward sierra and made the plumes of Eyath glow. Her crest was silhouetted against the Milky Way. Despite the moon, constellations glistened through upland air. Wheel, Swords, Zirraukh, vast sprawling Ship . . .

He sat down beside her, hugging his knees. She made the small ululation which expressed her gladness

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at his presence. He responded as best he could. Above the clean curve of her muzzle the great eyes glimmered.

Abruptly she broke off. He followed her gaze and saw a new star swing into heaven. "A guardian satellite?" she asked. Her tone wavered the least bit.

"What else?" he replied. "I think it must be the latest one they've orbited."

"How many by now?"

"They're not announcing that," he reminded her. Ythrians always had trouble grasping the idea of government secrets. Of government in any normal human sense, for that matter. Marchwardens Ferune and Holm had been spending more energy in getting the choths to cooperate than in actual defense preparations. "My father doesn't believe we can have too many."

"The wasted wealth—"

"Well, if the Terrans come—"

"Do you expect they will?"

The trouble he heard brought his hand to squeeze her, very gently, on the neck, and afterward run fingers along her crest. Her feathers were warm, smooth and yet infinitely textured. "I don't know," he said. "Maybe they can settle the border question peacefully. Let's hope." The last two words were pertarce in Anglic rather than Planna. Ythrians had never beseeched the future. She too was bilingual like every educated colonist.

His look went back skyward. Sol lay . . . yonder in the Maukh, about where four stars formed the horns . . . how far? Oh, yes, two hundred and five light-years. He recalled reading that, from there, Quetlan and Laura were in a constellation called the Lupus. None of the three suns had naked-eye visibility across such an abyss. They were mere G-type dwarfs; they merely happened to be circled by some motes which had fermented till there were chemistries that named those motes Terra, Ythri, Avalon, and loved them.

"Lupus," he mused. "An irony."

Eyath whistled: "?"

He explained, adding: "The lupus is, or was, a beast of prey on Terra. And to us, Sol lies in the sign of a big, tame herd animal. But who's attacking whom?"

"I haven't followed the news much," she said, low and not quite steadily. "It seemed a fog only, to me or mine. What need we reck if others clashed? Then all of a sudden—might we have caused some of the trouble, Arinnian? Could folk of ours have been too rash, too rigid?"

Her mood was so uncharacteristic, not just of Ythrian temperament in general but of her usually sunny self, that astonishment jerked his head around. "What's made you this anxious?" he asked.

Her lips nuzzled the uhoth, as if seeking consolation that he thought

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he could better give. Its beak preened her. He barely heard: "Vodan."

"What? Oh! Are you betrothed to Vodan?"

His voice had cracked. *Why am I shaken?* he wondered. *He's a fine fellow. And of this same choth, too; no problems of changed law and custom, culture shock, homesickness* . . . Arinnian's glance swept over the Stormgate country. Above valleys steep-walled, dark and fragrant with woods, snowpeaks lifted. Closer was a mountainside down which a waterfall stood pillarlike under the moon. A night-flying bugler sounded its haunting note through stillness. On the Plains of Long Reach, in arctic marshes, halfway around the planet on a scorching New Gaiilan savannah, amidst the uncounted islands that made up most of what dry land Avalon had—how might she come to miss the realm of her choth?

No, wait, I'm thinking like a human. Ythrians get around more. Eyath's own mother is from the Sagittarius basin, often goes back to visit . . . Why shouldn't I think like a human? I am one. I've found wisdom, rightness, happiness of a sort in certain Ythrian ways; but no use pretending I'll ever be an Ythrian, ever wed a winged girl and dwell in our own aerie.

She was saying: "Well, no, not exactly. Galemate, do you believe I wouldn't tell you of my betrothal or invite you to my wedding feast? But he is a . . . a person I've grown very fond of. You know I planned on staying single till my studies were finished." She wanted the difficult, honored calling of musician. "Lately . . . well, I thought about it a lot during my last lovetime. I grew hotter then than ever before, and I kept imagining Vodan."

Arinnian felt himself flush. He stared at the remote gleam of a glacier. She shouldn't tell him such things. It wasn't decent. An unmarried female Ythrian, or one whose husband was absent, was supposed to stay isolated from males when the heat came upon her; but she was also supposed to spend the energy it raised in work, or study, or meditation, or—

Eyath sensed his embarrassment. Her laughter rippled and she laid a hand over his. The slim fingers, the sharp claws gripped him tenderly. "Why, I declare you're shocked! What for?"

"You wouldn't talk like that to—your father, a brother—" *And you shouldn't feel that way, either. Never. Oestrous or no. Lonely, maybe; dreamy, yes; but not like some sweating trull in the bed of some cheap hotel room. Not you, Eyath.*

"True, it'd be improper talk in Stormgate. I used to wonder if I shouldn't marry into a less strict choth. Vodan, though—anyhow, Arinnian, dear, I can tell you anything. Can't I?"

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Yes." *After all, I'm not really an Ythrian.*

"We discussed it later, he and I," she said. "Marriage, I mean. No use denying, children would be a terrible handicap at this stage. But we fly well together; and our parents have been nudging us for a very time, it'd be so good an alliance between houses. We've wondered if maybe, if we stayed hric- a the first few years--"

That doesn't work too well, does it?" he said as her voice trailed off through the bloodbeat in his ears. "That is, uh, continual sex relations may not be how Ythrians reinforce pair bonds, but that doesn't mean sex has no importance. If you separate every love- time you well, you're rejecting each other, aren't you? Why not, uh, contraception?"

No.

He knew why her race, almost if not quite uniformly, spurned that. Children the strong parental instinct of both mates *were* what kept them together. If small wings closed around you and a small head snuggled down alongside your keelbone, you forgot the inevitable tensions and frustrations of marriage as much as if you were a human who had just happily coupled.

We could postpone things till I've finished my studies and his business is on the wing," Eyath said. Arminian remembered that Avadan, in partnership with various others from Stormgate. Many Thermals, and The Tarns, had launched a silvicultural engineering firm. "But if war comes--kaah, he's in the naval reserve--"

Her free arm went around his shoulder, a blind gesture. He leaned his weight on an elbow so he could reach beneath the wings to embrace her stiff body. And he murmured to her, his sister since they both were children, what comfort he was able.

In the morning they felt more cheerful. It was not in Ythrian nature to brood--not even as a bad pun, they giving live birth--and bird-humans had tried to educate themselves out of the habit. Today, apart from a few retainers on maintenance duty, Lythran's household would fly to that mountain where the regional Khruath met. On the way they would be joined by other Stormgate families; arrived, they would find other choths entirely. However bleak the occasion of this gathering was, some of the color, excitement, private business and private fun would be there that pervaded the regular assemblies.

And the dawn was clear and a tailwind streamed.

A trumpet called. Lythran swung from the top of his tower. Folk lifted their wings until the antlibranch slits beneath stood agape, purple from blood under the oxygen-drinking tissues. The wings clapped back down, and back on

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high; the Ythrians thundered off the ground, caught an updraft, and rode it into formation. Then they flew eastward over the crags.

Arinnian steered close to Eyath. She flashed him a smile and broke into song. She had a beautiful voice—it could nearly be named soprano—which turned the skirls and gutturals of Planha into a lilt. What she cataracted forth on the air was a traditional carol, but it was for Arinnian because he had rendered it into Anglic, though he always felt that his tricks of language had failed to convey either the rapture or the vision.

"Light that leaps from a sun still sunken
hails the hunter at hover,
washes his wings in molten morning,
startles the stars to cover.
Blue is the bell of hollow heaven,
rung by a risen blowing.
Wide lie woodlands and mountain meadows,
great and green with their growing.
But—look, oh, look!—
a red ray struck
through tattered mist.
A broadhorn buck
stands traitor-kissed.
The talons crook.

"Tilt through tumult of wakened wind-noise,
whining, whickering, whirly;
slip down a slantwise course of currents.
Ha, but the hunt comes early!
Poise on the pinions, take the target
there in the then of swooping—
Thrust on through by a wind-wild wingbeat,
stark the stabber comes stooping.
The buck may pose
for one short breath
before it runs
from whistling death.
The hammer stuns.
The talons close.

"Broad and bright is the nearing noontide.
Drawn to dreamily drowsing,
shut-eyed in shade he sits now, sated.
Suddenly sounds his rousing.
Cool as the kiss of a ghost, then gusty,
rinsed by the rainfall after,
breezes brawl, and their forest fleetness
lives in leafage like laughter.
Among the trees
the branches shout
and groan and throw
themselves about.
It's time to go.
The talons ease.

"Beat from boughs up to row through rainstreams.
Thickly thutters the thunder.
Hailwinds harried by lash of lightning
roar as they rise from under.
Blind in the black of clawing cloudbanks,
wins he his way, though slowly,

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breaks their barrier, soars in sunlight.
High is heaven and holy.
The glow slants gold
caressingly
across and through
immensity
of silent blue.
The talons fold."

II

Avalon rotates in 11 hours, 22 minutes, 12 seconds, on an axis tilted 21 degrees from the normal to the orbital plane. Thus Gray, at about 43 degrees north, knows short nights always; in summer the darkness seems scarcely a blink. Daniel Holm wondered if that was a root of his weariness.

Probably not. He was born here. His ancestors had lived here for centuries; they arrived with Falkayn. If individuals could change their circadian rhythms—as he'd had to do plenty often in his spacefaring days—surely a race could. The medics said that settling down in a gravity field only eighty percent of Terra's made more severe demands than that on the organism; its whole fluid balance and kinesthesia must readjust. Besides, what humans underwent was trivial compared to what their fellow colonists did. The Ythrians had had to shift a whole breeding cycle to a different day, year, weight, climate, diet, world. No wonder their first several generations had been of low fertility. Nevertheless, they survived: in the end, they flourished.

Therefore it was nonsense to suppose a man got tired from anything except overwork—and, yes, age, in spite of antisenescence. Or was it? Really? As you grew old, as you neared your dead and all who had gone before them, might your being not yearn back to its earliest beginnings, to a manhome you had never seen but somehow remembered?

Crock! Come off that! Who said eighty-four is old? Holm yanked a cigar from his pocket and snapped off the end. The inhalation which lit it was unnecessarily hard.

He was of medium height, and stocky in the olive tunic and baggy trousers worn by human members of the Ythrian armed services. The mongoloid side of his descent showed in round head, wide face, high cheekbones, a fullness about the lips and the blunt nose; the caucasoid was revealed in gray eyes, a skin that would have been pale did he not spend his free time outdoors hunting or gardening, and the hair that was grizzled on his scalp but remained crisp and black on his chest. Like most men on the planet, he suppressed his beard.

He was wading into the latest spate of communications his aides had passed on to him, when the intercom buzzed and said: "First Marchwarden Ferune wishes discussion."

"Sure!" Holm's superior was

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newly back from Ythri. The man reached for a two-way plate, withdrew his hand, and said, "Why not in the flesh? I'll be right there."

He stumped from his office. The corridor beyond hummed and bustled—naval personnel, civilian employees of the Lauran admiralty—and overloaded the building's air system till the odors of both species were noticeable, slightly acrid human and slightly smoky Ythrian. The latter beings were more numerous, in reversal of population figures for Avalon. But then, a number were here from elsewhere in the Domain, especially from the mother world, trying to help this frontier make ready in the crisis.

Holm forced himself to call greetings right and left as he went. His affability had become a trademark whose value he recognized. *At first it was genuine,* he thought.

The honor guard saluted and admitted him to Ferune's presence. (Holm did not tolerate time-wasting ceremoniousness in his department, but he admitted its importance to Ythrians.) The inner room was typical: spacious and sparsely furnished, a few austere decorations, bench and desk and office machinery adapted to ornithoid requirements. Rather than a transparency in the wall, there was a genuine huge window, open on garden-scented breezes and a downhill view of Gray and the waters aglitter beyond.

Ferune had added various offplanet souvenirs and a bookshelf loaded with folio copies of the Terran classics that he read, in three original languages, for enjoyment. A smallish, tan-feathered male, he was a bit of an iconoclast. His choth, Mistwood, had always been one of the most progressive on Avalon, mechanized as much as a human community and, in consequence, large and prosperous. He had scant patience to spare for tradition, religion, any conservatism. He endured a minimum of formalities because he must, but never claimed to like them.

Bouncing from his perch, he scuttled across the floor and shook hands Terran style. "Khr-r-r, good to see you, old rascal!" He spoke Planha; Ythrian throats are less versatile than human (though of course no human can ever get the sounds quite right) and he wanted neither the nuisance of wearing a vocalizer nor the grotesquerie of an accent.

"How'd it go?" Holm asked.

Ferune grimaced. But that is the wrong word. His feathers were not simply more intricate than those of Terran birds, they were more closely connected to muscles and nerve endings, and their movements constituted a whole universe of expression forever denied to man. Irritation, fret, underlying anger and dismay, rippled across his body.

"Huh." Holm found a chair de-

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signed for him, sank down, and drew tobacco pungency over his tongue. "Tell."

Foot-claws clicked on lovely grained wood. Back and forth Ferune paced. "I'll be dictating a full report," he said. "In brief, worse than I feared. Yes, they're scrambling to establish a unified command and shove the idea of action under doctrine into every captain. But they've no dustiest notion of how to go about it."

"God on a stick," Holm exclaimed, "we've been telling them for the past five years! I thought—of course, communication's so vague in this so-called navy. I'd nothing to go on but impressions, and I guess I got the wrong ones—but you know I thought we thought a halfway sensible reorganization was in progress."

It was, but it moulted. Overweening pride, bickering, haggling about details. We Ythrians our dominant culture, at least—don't fit well into anything tightly centralized." Ferune paused. "In fact," he went on, "the most influential argument against trading our separate, loose, coordinated planetary commands for a Terran-model hierarchy has been that Terra may have vastly greater forces, but these need to control a vastly greater volume of space than the Domain; and if they fight us, they'll be at the end of such a long line of communication that unified action is self-defeating."

"Huh! Hasn't it occurred to those mudbrains on Ythri, the Imperium isn't stupid? If Terra hits, it won't run the war from Terra, but from a sector close to our borders."

"We've found little sign of strength being marshalled in nearby systems."

"Certainly not!" Holm slammed a fist on the arm of his chair. "Would they give their preparations away like that? Would you? They'll assemble in space, parsecs from any star. Minimal traffic between the gathering fleet and whatever planets our scouts can sneak close to. In a few cubic light-years, they can hide power to blow us out of the plenum."

"You've told me this a few times," Ferune said dryly. "I've passed it on. To scant avail." He stopped pacing. For a while, silence dwelt in the room. The yellow light of Laura cast leaf shadows on the floor. They quivered.

"After all," Ferune said, "our methods did save us during the Troubles."

"You can't compare war lords, pirates, petty conquerors, barbarians who'd never have gotten past their stratospheres if they hadn't happened to've acquired practically self-operating ships—you can't compare that bloody-clawed rabble to Imperial Terra."

"I know," Ferune replied. "The point is, Ythrian methods served us well because they accord with Ythrian nature. I've begun to wonder,

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during this last trip, if an attempt to become poor copies of our rivals may not be foredoomed. The attempt's being made, understand—you'll get details till they run back out of your gorge—but could be that all we'll gain is confusion. I've decided that while Avalon must make every effort to cooperate, Avalon must at the same time expect small help from outside."

Again fell stillness. Holm looked at his superior, associate, friend of years; and not for the first time, it came to him what strangers they two were.

Standing, the Marchwarden was about 120 centimeters high from feet to top of crest; a tall person would have gone to 140 or so, say up to the mid-breast of Holm. Since the body tilted forward, its actual length from muzzle through tail was somewhat more. It massed perhaps 20 kilos; the maximum for the species was under 30.

The head looked sculptured. It bulged back from a low brow to hold the brain. A bony ridge arched down in front to a pair of nostrils, nearly hidden by feathers, which stood above a flexible mouth full of sharp white fangs and a purple tongue. The jaw, underslung and rather delicate, merged with a strong neck. That face was dominated by its eyes, big and amber, and by the dense, scalloped feather-crest that rose from the brow, lifted over the head, and ran half the length of the neck: partly for aerodynamic purposes, partly as a helmet on the thin skull.

The torso thrust outward in a great keelbone, which at its lower end was flanked by the arms. These were not unlike the arms of a skinny human, in size and appearance; they lacked plumage, and the hide was dark yellow on Ferune's, brown or black in other Ythrian subspecies. The hands were less manlike. Each bore three fingers between two thumbs; each digit possessed one more joint than its Terran equivalent and a nail that might better be called a talon. The wrist sprouted a dew claw on its inner surface. Those hands were large in proportion to the arms, and muscles played snakishly across them; they had evolved as ripping tools, to help the teeth. The body ended in a fan-shaped tail of feathers, rigid enough to help support it when desired.

At present, though, the tremendous wings were folded down to work as legs. In the middle of either leading edge, a "knee" joint bent in reverse; those bones would lock together in flight. From the "ankle," three forward toes and one rearward extended to make a foot; aloft, they curled around the wing to strengthen and add sensitivity. The remaining three digits of the ancestral ornithoid had fused to produce the alatan bone which swept backward for more than a meter. The skin over its front half

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was bare, calloused, another surface to rest on.

Ferune being male, his crest rose higher than a female's, and it and the tail were white with black trim; on her they would have been of uniform dark lustrousness. The remainder of him was lighter colored than average for his species, which ranged from gray-brown through black.

"Khr-r-r-r." The throat-noise yanked Holm out of his reverie. "You stare."

"Oh. Sorry." To a true-born carnivore that was more rude than it was among omnivorous humans. "My mind wandered."

"Whither?" Ferune asked, mild again.

"Hm-m-m . . . well—well, all right. I got thinking how little my breed really counts for in the Domain. I figure maybe we'd better assume everything's bound to be done Ythrian style, and make the best of that."

Ferune uttered a warbling "reminder" note and quirked certain feathers. This had no exact Anglic equivalent, but the intent could be translated as: "Your sort aren't the only non-Ythrians under our hegemony. You aren't the only ones technologically up to date." Planha was in fact not as laconic as its verbal conventions made it seem.

"No, no," Holm mumbled. "But we are the Empire, we're the leaders. Sure, Greater Terra includes quite a few home worlds and colonies of nonhumans; and a lot of individuals from elsewhere have gotten Terran citizenship, sure. But more humans are in key positions of every kind than members of any other race—fireflare, probably of all the other races put together." He sighed and stared at the glowing end of his cigar. "Here in the Domain, what are men? A handful on this single ball. Oh, we get around, we do well for ourselves, but the fact won't go away that we're a not terribly significant minority in a whole clutch of minorities."

"Do you regret that?" Ferune asked quite softly.

"Huh? No. No. I only meant, well, probably the Domain has too few humans to explain and administer a human-type naval organization. So better we adjust to you than you to us. It's unavoidable anyhow. Even on Avalon, where there're more of us, it's unavoidable."

"I hear a barrenness in your tone and see it in your eyes," Ferune said, more gently than was his want. "Again you think of your son who has gone bird, true? You fear his younger brothers and sisters will fare off as he did."

Holm gathered strength to answer. "You know I respect your ways. Always have, always will. Nor am I about to forget how Ythri took my people in when Terra had rotted away beneath

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them. It's just . . . just . . . we rate respect too. Don't we?"

Ferune moved forward until he could lay a hand on Holm's thigh. He understood the need of humans to speak their griefs.

"When he—Chris—when he first started running around, flying around, with Ythrians, why, I was glad," the man slogged on. He held his gaze out the window. From time to time he dragged at his cigar, but the gesture was mechanical, unnoticed. "He'd always been too bookish, too alone. So his Stormgate friends, his visits there—later, when he and Eyath and their gang were knocking around in odd corners of the planet—well, that seemed like he was doing over what I did at his age, except he'd have somebody to guard his back if a situation got sharp. I thought maybe he also would end enlisting in the Navy—" Holm shook his head. "I didn't see till too late, what'd gotten in him was not old-fashioned fiddlefootedness. Then when I did wake up, and we quarreled about it, and he ran off and hid in the Shielding Islands for a year, with Eyath's help—but no point in my going on, is there?"

Ferune gestured negative. After Daniel Holm went raging to Lythran's house, accusations exploding out of him, it had been all the First Marchwarden could do to intervene, calm both parties and prevent a duel.

"No, I shouldn't have said anything today," Holm continued. "It's only—last night Rowena was crying. That he went off and didn't say good-bye to her. Mainly, she worries about what's happening to him, inside, since he joined the choth. Can he ever make a normal marriage, for instance? Ordinary girls aren't his type any more; and bird girls—and, right, our younger kids. Tommy's completely in orbit around Ythrian subjects. The school monitor had to come in person and tell us how he'd been neglecting to screen the material or submit the work or see the consultants he was supposed to. And Jeanne's found a couple of Ythrian playmates—"

"As far as I know," Ferune said, "humans who entered choths have as a rule had satisfactory lives. Problems, of course. But what life can have none? Besides, the difficulties ought to become less as the number of such persons grows."

"Look," Holm floundered, "I'm not against your folk. Break my bones if ever I was! Never once did I say or think there was anything dishonorable about what Chris was doing, any more than I would've said or thought it if, oh, if he'd joined some celibate order of priests. But I'd not have liked that either. It's no more natural for a man. And I've studied everything I could find about bird people. Sure, most of them have claimed they were happy. Probably most of them believed it. I can't help think-

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ing they never realized what they'd missed."

"Walkers," Ferune said. In Planha that sufficed. In Anglic he would have had to state something like "We've lost our share, those who left the choths to become human-fashion atomic individuals within a global human community."

"Influence," he added, which conveyed. "Over the centuries on Avalon, no few of our kind have grown bitter at what your precept and example were doing to the choths themselves. Many still are. I suspect that's a major reason why several such groups have become more reactionary than any on the mother world."

Holm responded, "Wasn't the whole idea of this colony that both races should grant each other the right to be what they were?"

"That was written into the Compact and remains there," Ferune said in two syllables and three expressions. "Nobody has been compelled. But living together, how can we help changing?"

"Hmph. Because Ythri in general and Mistwood in particular have made a success of adopting and adapting Terran technology, you believe nothing's involved except a common-sense swap of ideas. It's not that simple, though."

"I didn't claim it is," Ferune said. "only that we don't catch time in any net."

"Yeah, I'm sorry if I—well, I didn't mean to maunder on, especially when you've heard me often enough before. These just happen to be thin days at home." The man left his chair, strode past the Ythrian, and halted by the window, where he looked out through a veil of smoke.

"Let's get to real work," he said. "I'd like to ask specific questions about the overall state of Domain preparedness. And you'd better listen to me about what's been going on here while you were away—through the whole bloody-beflensed Lauran System, in fact. That's none too good either."

III

The car identified its destination and moved down. Its initial altitude was such that the rider inside glimpsed a dozen specks of ground strewn over shining waters. But when he approached they had all fallen beneath the horizon. Only the rugged cone of St. Li was now visible to him.

With an equatorial diameter of a mere 11,308 kilometers, Avalon has a molten core smaller in proportion than Terra's; a mass of 0.635 cannot store as much heat. Thus the forces are weak that thrust land upward. At the same time, erosion proceeds fast. The atmospheric pressure at sea level is similar to the Terrestrial—and drops off more slowly with height, because of the

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gravity gradient—and rapid rotation makes for violent weather. In consequence, the surface is generally low, the highest peak in the Andromedas rising no more than 4,500 meters. Nor does the land occur in great masses. Corona, capping the north pole and extending down past the Tropic of Swords, covers barely eight million square kilometers, about the size of Australia. In the opposite hemisphere, Equatoria, New Africa, and New Gaiila could better be called large islands than minor continents. All else consists of far smaller islands.

Yet one feature is gigantic. Some 2,000 kilometers due west of Gray begins that drowned range whose peaks, thrusting into air, are known as Oronesia. Southward it runs, crosses the Tropic of Spears, trails off at last not far from the Antarctic Circle. Thus it forms a true, hydrological boundary; its western side marks off the Middle Ocean, its eastern the Hesperian Sea in the northern hemisphere and the South Ocean beyond the equator. It supports a distinct ecology, incredibly rich. And thereby, after the colonization, it became a sociological phenomenon. Any eccentrics, human or Ythrian, could go off, readily transform one or a few isles, and make their own undisturbed existence.

The mainland choths were diverse in size as well as in organization and tradition. But whether they be roughly analogous to clans, tribes, baronies, religious communes, republics, or whatever, they counted their members in the thousands at least. In Oronesia there were single households which bore the name; grown and married, the younger children were expected to found new, independent societies.

Naturally, this extremism was exceptional. The Highsky folk in particular were numerous, controlling the fisheries around latitude 30 degrees north and occupying quite a stretch of the archipelago. And they were fairly conventional, insofar as that word has any meaning when applied to Ythrians.

The aircar landed on the beach below a compound. He who stepped out was tall, with dark red hair, clad in sandals, kilt, and weapons.

Tabitha Falkayn had seen the vehicle descending and walked forth to meet it. "Hello, Christopher Holm," she said in Anglic.

"I come as Arinnian," he answered in Planha. "Luck fare beside you, Hrill."

She smiled. "Excuse me if I don't elaborate the occasion." Shrewdly: "You called ahead that you wanted to see me on a public matter. That must have to do with the border crisis. I daresay your Khruath decided that western Corona and northern Oronesia must work out a means of defending the Hesperian Sea."

He nodded awkwardly, and his

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eyes sought refuge from her amusement.

Enormous overhead, sunshine brilliant off cumulus banks, arched heaven. A sailor winged yonder, scouting for schools of piscoid; a flock of Ythrian shuas flapped by under the control of a herder and his uhoths; native pteropleuron lumbered around a reef rookery. The sea rolled indigo, curled in translucent green breakers, and exploded in foam on sands nearly as white. Trawlers plied it, kilometers out. Inland the ground rose steep. The upper slopes still bore a pale emerald mat of susin; only a few kinds of shrub were able to grow past those interlocking roots. But further down the hills had been plowed. There Ythrian clustergrain rustled red, for ground cover and to feed the shuas, while groves of coconut palm, mango, orange, and pumpernickel plant lifted above to nourish the human members of Highsky. A wind blew, warm but fresh, full of salt and iodine and fragrances.

"I suppose it was felt bird-to-bird conferences would be a good idea," Tabitha went on. "You mountaineers will have ample trouble understanding us pelagics, and vice versa, without the handicap of differing species. Ornithoids will meet likewise, hm-m-m?" Her manner turned thoughtful: "You had to be a delegate, of course. Your area has so few of your kind. But why come in person? Not that you aren't welcome. Still, a phone call--"

"We . . . we may have to talk at length," he said. "For days, off and on." He took for granted he would receive hospitality; all choths held that a guest was sacred.

"Why me, though? I'm only a local."

"You're a descendant of David Falkayn."

"That doesn't mean much."

"It does where I live. Besides—well, we've met before, now and then, at the larger Khruaths and on visits to each other's home areas and—we're acquainted a little. I'd not know where to begin among total strangers. If nothing else, you . . . you can advise me whom to consult, and introduce me. Can't you?"

"Certainly." Tabitha took both his hands. "Besides, I'm glad to see you, Chris."

His heart knocked. He struggled not to squirm. *What makes me this shy before her?* God knew she was attractive. A few years older than him, big, strongly built, full-breasted and long of leg, she showed to advantage in a short sleeveless tunic. Her face was snub-nosed, wide of mouth, its green eyes set far apart under heavy brows; she had never bothered to remove the white scar on her right cheekbone. Her hair, cropped beneath the ears, was bleached flaxen. It blew like banners over the brown, slightly freckled skin.

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He wondered if she went as casually to bed as the Coronan bird girls—never with a male counterpart; always a hearty, husky, not over-intelligent worker type—or if she was a virgin. That seemed unlikely. What human, perpetually in a low-grade lovetime, could match the purity of an Eyath? Yet Highsky wasn't Stormgate or The Tarns—he didn't know—Tabitha had no companions of her own species here where she dwelt—however, she traveled often and widely—he cast the speculation from him.

"Hoy, you're blushing," she laughed. "Did I violate one of your precious mores?" She released him. "If so, I apologize. But you always take these things too seriously. Relax. A social rite or a social gaff isn't a deathpride matter."

Easy for her, I suppose, he thought. *Her grandparents were received into this choth. Her parents and their children grew up in it. A fourth of the membership must be human by now. And they've influenced it—like this commercial fishery she and Draun have started, a strictly private enterprise—*

"I'm afraid we've no time for gaiety," he got out. "We've walking weather ahead."

"Indeed?"

"The Empire's about to expand our way."

"C'mon to the house." Tabitha took his arm and urged him toward the compound. Its thatch-roofed timber dwellings were built lower than most Ythrian homes and were sturdier than they seemed; for here was scant protection from Avalon's hurricanes. "Oh, yes," she said, "the Empire's been growing vigorously since Manuel the First. But I've read its history. How has the territory been brought under control? Some by simple partnership—civilized nonhumans like the Cynthians found it advantageous. Some by purchase or exchange. Some by conquest, yes—but always of primitives, or at most of people whose strength in space was ridiculously less than Greater Terra's. We're a harder gale to buck."

"Are we? My father says—"

"Uh-huh. The Empire's sphere approaches four hundred light-years across, ours about eighty. Out of all the systems in its volume, the Empire's got a degree of direct contact with several thousand, we with barely two hundred and fifty. But don't you see, Chris, we know our planets better? We're more compact. Our total resources are less but our technology's every bit as good. And then, we're distant from Terra. Why should they attack us? We don't threaten them, we merely claim our rights along the border. If they want more realm, they can find plenty closer to home, suns they've never visited, and easier to acquire than from a proud, well-armed Domain."

"My father says we're weak and unready."

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"Do you think we would lose a war?"

He fell silent until they both noticed through the soughing ahead, how sand scrunched beneath their feet. At last: "Well, I don't imagine anybody goes into a war expecting to lose."

"I don't believe they'll fight," Tabitha said. "I believe the Imperium has better sense."

"Regardless, we'd better take precautions. Home defense is among them."

"Yes. Won't be easy to organize, among a hundred or more sovereign choths."

"That's where we birds come in, maybe," he ventured. "Long-established ones in particular, like your family."

"I'm honored to help," she told him. "And in fact I don't imagine the choths will cooperate too badly," she tossed her head in haughtiness, "when it's a matter of showing the Empire who flies highest!"

Eyath and Vodan winged together. They made a handsome pair, both golden of eyes and arms, he ocher-brown and she deep bronze. Beneath them reached the Stormgate lands, forest-darkened valleys, crags and cliffs, peaks where snowfields lingered to dapple blue-gray rock, swordblade of a waterfall and remote blink of a glacier. A wind sang *whoo* and drove clouds, which Laura tinged gold, through otherwise brilliant air; their shadows raced and rippled across the world. The Ythrians drank of the wind's cold and swam in its swirling, thrusting, flowing strength. It stroked their feathers till they felt the barbs of the great outer pinions shiver.

He said: "If we were of Arinnian's kind, I would surely wed you now, before I go to my ship. But you won't be in lovetime for months, and by then I might be dead. I would not bind you to that sorrow for nothing."

"Do you think I would grieve less if I had not the name of widow?" she answered. "I'd want the right to lead your memorial dance. For I know what parts of these skies you like best."

"Still, you would have to lift some awkward questions, obligation toward my blood and so on. No. Shall our friendship be less because, for a while, you have not the name of wife?"

"Friendship," she murmured. Impulsively: "I dreamt last night that we were indeed like humans."

"What, forever in rut?"

"Forever in love."

"Kh-h'ng, I've naught against Arinnian, but sometimes I wonder if you've not been too much with him, for too many years since you both were small. Had Lythran not taken you along when he had business in Gray--" Vodan saw her crest rise, broke off and added in haste: "Yes, he's your galemate.

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That makes him mine too. I only wanted to warn you . . . don't try, don't wish to be human."

"No, no." Eyath felt a downdraft slide by. She slanted herself to catch it, a throb of wings and then the long wild glide, peaks leaping nearer, glimpse through trees of a pool ashine where a feral stallion drank, song and rush and caress of cloven air, till she checked herself and flew back upward, breasting a torrent, every muscle at full aliveness—traced a thermal by the tiny trembling of a mountain seen through it, won there, spread her wings and let heaven carry her hovering while she laughed.

Vodan beat near. "Would I trade this?" she called joyously. "Or you?"

Ekrem Saracoglu, Imperial Governor of Sector Pacis, had hinted for a while that he would like to meet the daughter of Fleet Admiral Juan de Jesús Cajal y Palomares. She had come from Nuevo México to be official hostess and feminine majordomo for her widowed father, after he transferred his headquarters to Esperance and rented a house in Fleurville. The date kept being postponed. It was not that the admiral disliked the governor—they got along well—nor distrusted his intentions, no matter how notorious a womanizer he was. Luisa had been raised among folk who, if strict out of necessity on their dry world, were rich in honor and bore a hair-trigger pride. It was merely that both men were overwhelmed by work.

At last their undertakings seemed fairly well along, and Cajal invited Saracoglu to dinner. A ridiculous last-minute contretemps occurred. The admiral phoned home that he would be detained at the office a couple of hours. The governor was already on his way.

"Thus you, Donna, have been told to keep me happy in the teeth of a postponed meal," Saracoglu purred over the hand he kissed. "I assure you, that will not be in the least difficult." Though small, she had a lively figure and a darkly pretty face. And he soon learned that, albeit solemn, she knew how to listen to a man and, rarer yet, ask him stimulating questions.

By then they were strolling in the garden. Rosebushes and cherry trees might almost have been growing on Terra; Esperance was a prize among colony planets. The sun Pax was still above the horizon, now at midsummer, but leveled mellow beams across an old brick wall. The air was warm, blithe with birdsong, sweet with green odors that drifted in from the countryside. A car or two caught the light, high above; but Fleurville was not big enough for its traffic noise to be heard this far from the centrum.

Saracoglu and Luisa paced along graveled paths and talked. They were guarded, which is to say dis-

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sreetly chaperoned. However, no duenna followed several paces behind, but a huge four-armed Gorzunian mercenary on whom the nuances of a flirtation would be lost.

The trouble is, thought the governor, *she's begun conversing in earnest.*

It had been quite pleasant at first. She encouraged him to speak of himself. . . . Yes, the Earl of Anatolia, that's me. Frankly, even if it is on Terra, a minor peerage. . . . Career bureaucrat. Might rather've been an artist—I dabble in oils and clays, maybe you'd care to see. . . . Alas, you know how such things go. Imperial nobles are expected to serve the Imperium. Had I but been born in a decadent era! Eh? Unfortunately, the Empire's not run out of momentum—"

Inwardly, he grinned at his own performance. He, fifty-three standard years of age, squat, running to fat, totally bald, little eyes set close to a giant nose, and two expensive mistresses in his palace—acting the role of a boy who acted the role of an *homme du monde!* Well, he enjoyed that once in a while, as he enjoyed gaudy clothes and jewels. They were a relaxation from the wry realism which had never allowed him to improve his appearance through biosculp.

But at this point she asked, "Are we really going to attack the Ythrians?"

"Heh?" The distress in her tone brought his head swinging sharply around to stare at her. "Why, negotiations are stalled, but—"

"Who stalled them?" She kept her own gaze straight ahead. Her voice had risen a note and the slight Espanyol accent had intensified.

"Who started most of the violent incidents?" he countered. "Ythrians. Not that they're monsters, understand. But they are predators by nature. And they've no strong authority—no proper government at all—to control the impulses of groups. That's been a major stumbling block in the effort to reach an accommodation."

"How genuine was the effort—on our side?" she demanded, still refusing to look at him. "How long have you planned to fall on them? My father won't tell me anything, but it's obvious, it's been obvious ever since he moved here—how often are naval and civilian headquarters on the same planet? It's obvious something is b-b-being readied."

"Donna," Saracoglu said gravely, "when a fleet of spacecraft can turn whole worlds into tombs, one prepares against the worst and one clamps down security regulations." He paused. "One also discovers it is unwise to let spheres interpenetrate, as Empire and Domain have. I daresay you, young, away off in a relatively isolated system . . . I daresay you got an idea the Imperium is provoking war in or-

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der to swallow the whole Ythrian Domain. That is not true."

"What is true?" She replied bitterly.

"That there have been bloody clashes over disputed territories and conflicting interests."

"Yes. Our traders are losing potential profits."

"Would that were the only friction. Commercial disputes are always negotiable. Political and military rivalries are harder. For example, which of us shall absorb the Antoranite-Kraokan complex around Beta Centauri? One of us is bound to, and those resources would greatly strengthen Terra. The Ythrians have already gained more power, by bringing Dathyna under them, than we like a potentially hostile race to have.

"Furthermore, by rectifying this messy frontier, we can armor ourselves against a Merseian flank attack." Saracoglu lifted a hand to forestall her protest. "Indeed, Donna, the Roidhunate is far off and not very big. But it's growing at an alarming rate, and aggressive acquisitiveness is built into its ideology. The duty of an empire is to provide for the great-grandchildren."

"Why can't we simply write a treaty, give a *quid pro quo*, divide things in a fair and reasonable manner?" Luisa asked.

Saracoglu sighed. "The populations of the planets would object to being treated like inanimate property. No government which took that attitude would long survive." He gestured aloft. "Furthermore, the universe holds too many unknowns. We have traveled hundreds—in earlier days, thousands—of light-years to especially interesting stars. But what myriads have we bypassed? What may turn up when we do seek them out? No responsible authority, human or Ythrian, will blindly hand over such possibilities to an alien.

"No, Donna, this is no problem capable of neat, final solutions. We just have to do our fumbling best. Which does *not* include subjugating Ythri. I'm the first to grant Ythri's right to exist, go its own way, even keep offplanet possessions. But this frontier must be stabilized."

"We—interpenetrate—with others—and have no trouble."

"Of course. Why should we fight hydrogen breathers, for example? They're so exotic we can barely communicate with them. The trouble is, the Ythrians are too like us. As an old, old saying goes, two tough, smart races want the same real estate."

"We can live with them! Humans are doing it. They have for generations."

"Do you mean Avalon?"

She nodded.

Saracoglu saw a chance to divert the conversation back into easier channels. "Well, there's an interesting case, certainly," he smiled. "Do you know much about it?"

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"Very little," she admitted, subdued. "A few mentions here and there, since I came to Esperance. The galaxy's so huge, this tiny fleck of it we've explored. . . ."

"You might get to see Avalon," he said. "Not far off, ten or twelve light-years. I'd like that myself. The society does appear to be unusual, if not absolutely unique."

"Don't you understand? If humans and Ythrians can share a single planet—"

"That's different. Allow me to give you some background. I've never been there either, but I've studied material on it since getting this appointment."

Saracoglu drew breath. "Avalon was discovered five hundred years ago, by the same Grand Survey ship that came on Ythri," he said. "It was noted as a potential colony, but was so remote from Terra that nobody was interested then; the very name wasn't bestowed till long afterward. Ythri was forty light-years further, true, but much more attractive, a rich planet full of people vigorously entering the modern era who had a considerable deal to trade.

"About three and a half centuries back, a human company made the Ythrians a proposal. The Polesotechnic League wasn't going to collapse for another fifty years, but already anybody who had functional brains could read what a cutthroat period lay ahead. These humans, a mixed lot under the leadership of an old trade pioneer, wanted to safeguard the future of their families by settling on out-of-the-way Avalon—under the suzerainty, the protection, of an Ythri that was not corrupted as Technic civilization was. The Ythrians agreed, and naturally some of them joined the settlement.

"Well, the Troubles came, and Ythri was not spared. The eventual results were similar—Terra enforced peace by the Empire, Ythri by the Domain. In the meantime, standing together, bearing the brunt of chaos, the Avalonians had been welded into one.

"Nothing like that applies today."

They had stopped by a vine-covered trellis. He plucked a grape and offered it to her. She shook her head. He ate it himself. The taste held a slight, sweet strangeness; Esperancian soil was not, after all, identical with that of home. The sun was now gone from sight, shadows welled in the garden, an evening star blossomed.

"I suppose . . . your plans for 'rectification' . . . include bringing Avalon into the Empire," Luisa said.

"Yes. Consider its position." Saracoglu shrugged. "Besides, the humans there form a large majority. I rather imagine they'll be glad to join us, and Ythri won't mind getting rid of them."

"Must we fight?"

Saracoglu smiled. "It's never too

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late for peace." He took her arm. "Shall we go indoors? I expect your father will be here soon. We ought to have the sherry set out for him."

He'd not spoil the occasion, which was still salvageable, by telling her that weeks had passed since a courier ship brought what he requested: an Imperial rescript declaring war on Ythri, to be made public whenever governor and admiral felt ready to act.

IV

A campaign against Ythri would demand an enormous fleet, gathered from everywhere in the Empire. No such thing had been publicly seen or heard of, though rumors flew. But of course units guarding the border systems had been openly reinforced as the crisis sharpened, and drills and practice maneuvers went on apace.

Orbiting Pax at ten astronomical units, the Planet-class cruisers *Thor* and *Ansa* flung blank shells and torpedoes at each other's force screens, pierced these latter with laser beams that tried to hold on a single spot of hull for as long as an energy blast would have taken to gnaw through armor, exploded magnesium flares whose brilliance represented lethal radiation, dodged about on grav thrust, wove in and out of hyperdrive phase, used every trick in the book and a few which the high command hoped had not yet gotten into Ythrian books. Meanwhile the Comet- and Meteor-class boats they mothered were similarly busy.

To stimulate effort, a prize had been announced. That vessel the computers judged victorious would proceed with her auxiliaries to Esperance, where the crew would get a week's liberty.

Ansa won. She broadcast a jubilant recall. Half a million kilometers away, an engine awoke in the Meteor which her captain had dubbed *Hooting Star.*

"Resurrected at last!" Lt. (j.g.) Philippe Rochefort exulted. "And in glory at that."

"And unearned." The fire control officer, CPO Wa Chaou of Cynthia, grinned. His small white-furred body crouched on the table he had been cleaning after a meal; his bushy tail quivered like the whiskers around his blue-masked muzzle.

"What the muck you mean, 'unearned'?" the engineer-computerman, CPO Abdullah Helu, grumbled: a lean, middle-aged careerest from Huy Braseal. "Playing dead for three mortal days is beyond the call of duty." The boat had theoretically been destroyed in a dogfight and drifting free, as a real wreck would, to complicate life for detector technicians.

"Especially when the poker game cleaned and reamed you, eh?" Wa Chaou gibed.

"I won't play with you again, sir," Helu said to the captain-pilot.

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"No offense. You're just too mucking talented."

"Only luck," Rochefort answered. "Same as it was only luck that threw such odds against us. The boat acquitted herself well. As you did afterward, over the chips. Better luck to both next time."

She was his first, new and shiny command—he having recently been promoted from ensign for audacity in a rescue operation—and he was anxious for her to make a good showing. No matter how inevitable under the circumstances, defeat had hurt.

But they were on the top team; and they'd accounted for two opposition craft, plus tying up three more for a while that must have been used to advantage elsewhere; and now they were bound back to Avon and thence to Esperance, where he knew enough girls that dates were a statistical certainty.

The little cabin trembled and hummed with driving energies. Air gusted from ventilators, smelling of oil and of recycling chemicals. A Meteor was designed for high acceleration under both relativistic and hyperdrive conditions; for accurate placement of nuclear-headed torpedoes, and for no more comfort than minimally essential to the continued efficiency of personnel.

Star space lay around the viewports in a glory of stars, diamond-keen, unwinking, many-colored, crowding an infinitely clear blackness till they merged in the argent torrent of the Milky Way or the dim mysterious cloudlets which were sister galaxies. Rochefort wanted to sit, look, let soul follow gaze outward into God's temple, the universe. He could have done so, too; the boat was running on full automatic. But better demonstrate to the others that he was a conscientious as well as an easy-going officer. He turned the viewer back on which he had been using when the message came.

A canned lecture was barely under way. A human xenologist stood in the screen and intoned:

"Warm-blooded, feathered, and flying, the Ythrians are not birds; they bring their young forth viviparously after a gestation of four and a half months; they do not have beaks, but lips and teeth. Nor are they mammals; they grow no hair and secrete no milk; those lips have developed for parents to feed infants by regurgitation. And while the antlibranchs might suggest fish gills, they are not meant for water but for—"

"Oh, no!" Helu exclaimed. "Sir, won't you have time to study later? Devil knows how many more weeks we'll lie in orbit doing nothing."

"War may erupt at any minute," Wa Chaou said.

"And if and when, who cares how the enemy looks or what his love life is? His ships are about like ours, and that's all we're ever likely to see."

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"Oh, you have a direct line to the future?" the Cynthian murmured.

Rochefort stopped the tape and snapped, "I'll put the sound on tight beam if you want. But a knowledge of the enemy's nature might make the quantum of difference that saves us when the real thing happens. I suggest you watch too."

"Er, I think I should check out Number Three oscillator, long's we're not traveling faster-than-light," Helu said, and withdrew into the engine room. Wa Chaou settled down by Rochefort.

The lieutenant smiled. He refrained from telling the Cynthian, *You're a good little chap. Did you enlist to get away from the domination of irascible females on your home planet?*

His thought went on: *The reproductive pattern—sexual characteristics, requirements of the young—does seem to determine most of the basics in any intelligent species. As if the cynic's remark were true, that an organism is simply a DNA molecule's way of making more DNA molecules. Or whatever the chemicals of heredity may be on a given world. . . But no, a Jerusalem Catholic can't believe that. Biological evolution inclines, it does not compel.*

"Let's see how the Ythrians work," he said aloud, reaching for the switch.

"Don't you already know, sir?" Wa Chaou asked.

"Not really. So many sophont races, in that bit of space we've sort of explored. And I've been busy familiarizing myself with my new duties." Rochefort chuckled. "And, be it admitted, enjoying what leaves I could get."

He reactivated the screen. It showed an Ythrian walking on the feet that grew from his wings: a comparatively slow, jerky gait, no good for real distances. The being stopped, lowered hands to ground, and stood on them. He lifted his wings, and suddenly he was splendid.

Beneath, on either side, were slits in column. As the wings rose, the feathery operculum-like flaps which protected them were drawn back. The slits widened until, at full extension, they gaped like purple mouths. The view became a closeup. Thin-skinned tissues, intricately wrinkled, lay behind a curtain of cilia which must be for screening out dust.

When the wings lowered, the slits were forced shut again, bellows fashion. The lecturer's voice said: "This is what allows so heavy a body, under Terra-type weight and gas density, to fly. Ythrians attain more than twice the mass of the largest possible airborne creature on similar planets elsewhere. The antlibranchs, pumped by the wingstrokes, take in oxygen under pressure to feed it directly to the

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bloodstream. Thus they supplement lungs which themselves more or less resemble those of ordinary land animals. The Ythrian acquires the power needed to get aloft and, indeed, fly with rapidity and grace."

The view drew back. The creature in the holograph flapped strongly and rocketed upward.

"Of course," the dry voice said, "this energy must come from a correspondingly accelerated metabolism. Unless prevented from flying, the Ythrian is a voracious eater. Aside from certain sweet fruits, he is strictly carnivorous. His appetite has doubtless reinforced the usual carnivore tendency to live in small, well-separated groups, each occupying a wide territory which instinct makes it defend against all intruders.

"In fact, the Ythrian can best be understood in terms of what we know or conjecture about the evolution of his race."

"Conjecture more than know, I suspect," Rochefort remarked. But he found himself fascinated.

"We believe that homeothermic—roughly speaking, warm-blooded—life on Ythri did not come from a reptilian or reptiloid form, but directly from an amphibian, conceivably even from something corresponding to a lungfish. At any rate, it retained a kind of gill. Those species which were most successful on land eventually lost this feature. More primitive animals kept it. Among these was that small, probably swamp-dwelling thing which became the ancestor of the sophont. Taking to the treetops, it may have developed a membrane on which to glide from bough to bough. This finally turned into a wing. Meanwhile the gills were modified for aerial use, into superchargers."

"As usual," Wa Chaou observed, "the failures at one stage begot the successes of the next."

"Of course, the Ythrian can soar and even hover," the speaker said, "but it is the tremendous wing area which makes this possible, and the antlibranchs are what make it possible to operate those wings.

"Otherwise the pre-Ythrian must have appeared fairly similar to Terran birds." Pictures of various hypothetical extinct creatures went by. "It developed an analogous water-hoarding system—no separate urination—which saved weight as well as compensating for evaporative losses from the antlibranchs. It likewise developed light bones, though these are more intricate than avian bones, built of a marvelously strong two-phase material whose organic component is not collagen but a substance carrying out the functions of Terra-mammalian marrow. The animal did not, however, further ease its burdens by trading teeth for a beak. Many Ythrian ornithoids have done so, for example the uhoth, hawklike in

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appearance, doglike in service. But the pre-sophont remained an unspecialized dweller in wet jungles.

"The fact that the young were born tiny and helpless—since the female could not fly long distances while carrying a heavy fetus—is probably responsible for the retention and elaboration of the digits on the wings. The cub could cling to either parent in turn while these cruised after food; before it was able to fly, it could save itself from enemies by clambering up a tree. Meanwhile the feet acquired more and more ability to seize prey and manipulate objects.

"Incidentally, the short gestation period does not mean that the Ythrian is born with a poorly developed nervous system. The rapid metabolism of flight affects the rate of fetal cell division. This process concentrates on laying down a body pattern rather than on increasing the size. Nevertheless, an infant Ythrian needs more care, and more food, than an infant human. The parents must cooperate in providing this as well as in carrying their young about. Here we may have the root cause of the sexual equality or near equality found in all Ythrian cultures.

"Likewise, a rapid succession of infants would be impossible to keep alive under primitive conditions. This may be a reason why the female only ovulates at intervals of a year—Ythri's is about half of Terra's—and not for about two years after giving birth. Sexuality does not come overtly into play except at these times. Then it is almost uncontrollably strong in male and female alike. This may well have given the territorial instinct a cultural reinforcement after intelligence evolved. Parents wish to keep their nubile daughters isolated from chance-met males while in heat. Furthermore, husband and wife do not wish to waste a rich, rare experience on any outsider.

"The sexual cycle is not totally rigid. In particular, grief often brings on oestrous. Doubtless this was originally a provision of nature for rapid replacement of losses. It seems to have brought about a partial fusion of Eros and Thanatos in the Ythrian psyche which makes much of the race's art, and doubtless thought, incomprehensible to man. An occasional female can ovulate at will, though this is considered an abnormality; in olden days she would be killed, now she is generally shunned, out of dread of her power. A favorite villain in Ythrian story is the male who, by hypnosis or otherwise, can induce the state. Of course, the most important manifestation of a degree of flexibility is the fact that Ythrians have successfully adapted their reproductive pattern, like everything else, to a variety of colonized planets."

"Me, I think it's more fun being human," Rochefort said.

"I don't know, sir," Wa Chaou

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replied. "Superficially the relationship between the sexes looks simpler than in your race or mine; you're either in the mood or you're not, and that's that. I wonder, though, if it may not really be more subtle and complicated than ours, even more basic to the whole psychology."

"But to return to evolution," the lecturer was saying. "It seems that a major part of Ythri underwent something like the great Pliocene drought in Terra's Africa. The ornithoids were forced out of dwindling forests onto growing savannahs. There they evolved from carrion eaters to big-game hunters in a manner analogous to pre-man. The original feet became hands, which eventually started making tools. To support the body and provide locomotion on the ground, the original elbow claws turned into feet, the wings that bore them became convertible to legs of a sort.

"Still, the intelligent Ythrian remained a pure carnivore, and one which was awkward on land. Typically, primitive hunters struck from above, with spears, arrows, axes. Thus only a few were needed to bring down the largest beasts. There was no necessity to cooperate in digging pits for elephants or standing shoulder to shoulder against a charging lion. Society remained divided into families or clans, which seldom fought wars but which, on the other hand, did not have much contact of any sort.

"The revolution which ended the Stone Age did not involve agriculture from the beginning, as in the case of man. It came from the systematic herding, at last the domestication, of big ground animals like the maukh, smaller ones like the long-haired mayaw. This stimulated the invention of skids, wheels, and the like, enabling the Ythrian to get about more readily on the surface. Agriculture was invented as an ancillary to ranching, an efficient means of providing fodder. The food surplus allowed leisure for travel, trade, and widespread cultural intercourse. Hence larger, complex social units arose.

"They cannot be called civilizations in a strict sense, because Ythri has never known true cities. The mobility of being winged left no necessity for crowding together in order to maintain close relationships. Granted, sedentary centers did appear—for mining, metallurgy, and other industry; for trade and religion; for defense in case the group was defeated by another in aerial battle. But these have always been small and their populations mostly floating. Apart from their barons and garrisons, their permanent inhabitants were formerly, for the main part, wing-clipped slaves—today, automated machines. Clipping was an easy method of making a person controllable; yet since the feathers could grow back, the common practice of promising manumission after a certain period

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of diligent service tended to make prisoners docile. Hence slavery became so basic to pre-industrial Ythrian society that to this day it has not entirely disappeared."

Well, we're reviving it in the Empire, Rochefort thought. *For terms and under conditions limited by law; as a punishment, in order to get some social utility out of the criminal; nevertheless, we're bringing back a thing the Ythrians are letting die. How more moral are we than they? How much more right do we have?*

He straightened in his chair. *Man is my race.*

A willowy blond with the old-fashioned Esperancian taste for simplicity in clothes, Eve Davisson made a pleasing contrast to Philippe Rochefort, as both were well aware. He was a tall, rather slender young man, his bearing athletic, his features broad-nosed, full-lipped, and regular, his hair kinking itself into a lustrous black coif over the deep-brown skin. And he stretched to the limit the tolerance granted officers as regards their dress uniforms—rakishly tilted bonnet bearing the sunburst of Empire, gold-trimmed blue tunic, scarlet sash and cloak, snowy trousers tucked into low boots of authentic Terran beef-leather.

They sat in an intimate restaurant of Fleurville, by a window opening on gardens and stars. A live sonorist played something old and sentimental; perfumed, slightly intoxicant vapors drifted about; they toyed with hors d'oeuvres and paid more serious attention to their champagne. Nonetheless, she was not smiling.

"This world was settled by people who believed in peace," she said. Her tone mourned rather than accused. "For generations they kept no armed forces, they relied on the good will of others whom they helped."

"That good will didn't outlive the Troubles," Rochefort said.

"I know, I know. I shan't join the demonstrators, whatever some of my friends may say when they learn I've been out with an Imperial officer. But Phil, the star named Pax, the planet named Esperance are being geared for war. It hurts."

"It'd hurt worse if you were attacked. Avalon isn't far, and they've built a lot of power there."

Her fingers tightened on the stem of her glass. "Attack from Avalon? But I've *met* those people, both races. They've come here on trade or tour or—I made a tour there myself, not long ago. I went because it's picturesque, but was so graciously treated I didn't want to leave."

"I daresay Ythrian manners have rubbed off on their human fellows." Rochefort let a draught go over his palate, hoping it would tingle away his irritation. This wasn't supposed to be a political

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evening. "Likewise less pleasant features of the Ythrian personality."

She studied him through the soft light before she said, low, "I get an impression you disapprove of a mixed colony."

"Well . . . in a way, yes." He could have dissembled, facilely agreed to everything she maintained, and thus improved his chances of bedding her later on. But he'd never operated thus; and he never would, especially when he liked this girl just as a person. "I believe in being what you are and standing by your own."

"You talk almost like a human supremacist," she said, though mildly.

"To the extent that man is the leading race—furnishes most of the leaders—in Technic civilization, yes, I suppose you'd have to call me a human supremacist," he admitted. "It doesn't mean we aren't chronically sinful and stupid, nor does it mean we have any right to oppress others. Why, my sort of people are the xenosophont's best friend. We simply don't want to imitate him."

"Do you believe the Terran Empire is a force for good?"

"On balance, yes. It commits evil. But nothing mortal can avoid that. Our duty is to correct the wrongs . . . and also to recognize the values that the Empire does, in fact, preserve."

"You may have encountered too little of the evil."

"Because I'm from Terra itself?" Rochefort chuckled. "My dear, you're too bright to imagine the mother system is inhabited exclusively by aristocrats. My father is a minor functionary in the Sociodynamic Service. His job caused us to move around a lot. I was born in Selenopolis, which is a spaceport and manufacturing center. I spent several impressionable years on Venus, in the crime and poverty of a planet whose Terraforming never had been quite satisfactory. I joined the Navy as an enlisted rating—not out of chauvinism, merely a boyish wish to see the universe—and wasn't tapped for pilot school for two-three years; meanwhile, I saw the grim side of more than one world. Sure, there's a cosmos of room for improvement. Well, let's improve, not tear down. And let's defend!"

He stopped. "Damn," he said frankly. "I'd hoped to lure you out of your seriousness, and fell into it myself."

Now the girl laughed, and raised her glass. "Let's help each other climb out, then," she suggested.

They did. Rochefort's liberty became highly enjoyable. And that was fortunate, because two weeks after he reported back from it, *Ansa* was ordered into deep space. Light-years from Pax, she joined the fleet that had been using immensity as a mask for its marshalling; and ships by the hundreds hurled toward the Ythrian Domain.

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V

The conference was by phone. Most were, these days. It went against old Avalonian courtliness but saved time—and time was getting in mighty short supply, Daniel Holm thought.

Anger crackled through clearly enough. Two of the three holographs on the comboard before him seemed about to climb out of their screens and into his office. No doubt he gave their originals the same impression.

Matthew Vickery, President of the Parliament of Man, wagged his forefinger and both plump jowls and said, "We are not under a military regime, may I remind you in case you have forgotten. We, the proper civil government, approved your defense measures of the past several years, though you are aware that I myself have always considered them excessive. When I think of the prosperity that tax money, those resources could have brought, left in private hands—or the social good it could have done in the public sector . . . Give you military your heads, and you'd build bases in the fourth dimension to protect us against an invasion from the future."

"We are always being invaded by the future," Ferune said. "The next part of it to arrive will not be pleasant."

Holm crossed his legs, leaned back, blew cigar smoke at Vickery's image, and drawled, "Spare us the oratory. You're not campaigning for re-election here. What's made you demand this four-way?"

"Your entire high-handedness," Vickery declared. "The overflow quantum was that last order, barring non-Ythrian ships from the Lauran System. Do you realize what a trade we do . . . not merely with the Empire, though that supports many livelihoods, but with unaffiliated civilizations like the Kraokan?"

"Do *you* realize how easy it'd be for the Terrans to get a robotic job, disguised, into low orbit around Avalon?" Holm retorted. "Several thousand megatons, touched off at that height when skies are clear, would set about half of Corona afire. Or it might be so sophisticated it could land like a peaceful merchantman. Consciousness-level computers aren't used much any more, when little new exploration's going on, but they could be built, including a suicide imperative. That explosion would be inside a city's force shields; it'd take out the generators, leaving what was left of the city defenseless; fallout from a dirty warhead would poison the whole hinterland. And you, Vickery, helped block half the appropriation we wanted for adequate shelters."

"Hysteria," the president said. "What could Terra gain from a one-shot atrocity? Not that I expect war, if only we can curb our own

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hotheads. But well, take this ludicrous home guard program you've instigated." His glance went toward Ferune and Liaw. "Oh, it gives a lot of young folk a fine excuse to swagger around, getting in people's ways, ordering them arrogantly about, feeling important, and never mind the social as well as the fiscal cost of it. But if this navy we've been building and manning at your loud urging, by straining our production facilities and gutting our resources, if this navy is as advertised, the Terrans can never come near us. If not, who has been derelict in his duty?"

"We are near their sector capital," Ferune reminded him. "They may strike us first, overwhelmingly."

"I've heard that till I'm taped for it. I prefer to program myself, thank you." Vickery paused. "See here," he continued in a leveled tone, "I agree the situation is critical. We're all Avalonians together. If I feel certain of your proposals are unwise, I tell this to the public and the Parliament. But in the end we compromise like reasonable beings."

Ferune's face rippled. It was as well that Vickery didn't notice or wasn't able to read the meaning. Liaw of The Tarns remained expressionless. Holm grunted. "Go on."

"I must protest both your proceedings and the manner of them," Vickery said. "We are not under martial law, and indeed the Compact makes no provision for declaring it."

"Wasn't needed in the old days," Holm said. "The danger was clear and present. I didn't think it'd be needed now. The Admiralty is responsible for local defense and liaison with armed forces elsewhere in the Domain—"

"Which does *not* authorize you to stop trade, or raise a tin militia, or anything cutting that deeply into normal Avalonian life. My colleagues and I have endured it thus far, recognizing the necessity of at least some things. But today the necessity is to remind you that you are the servants of the people, not the masters. If the people want your policies executed, they will so instruct their legislative representatives."

"The Khruaths did call for a home guard and for giving the Admiralty broad discretion," Liaw of The Tarns said in his rustling voice. He was old, had frost in his feathers; but he sat huge in his castle, and the screen gave a background image of crags and a glacier.

"Parliament—"

"Is still debating," Holm interrupted to finish. "The Terran Imperium has no such handicap. If you want a legal formula, well, consider us to be acting under choth law."

"The choths have no government," Vickery said, reddening.

"What is a government?" asked

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Liaw, Wyvan of the High Khruath—how softly!

"Why . . . well, legitimate authority—"

"Yes. The legitimacy derives, ultimately, no matter by what formula, from tradition. The authority derives, no matter by what formula, from armed force. Government is that institution which is legitimized in its use of physical coercion on the people. Have I read your human philosophers and history aright, President Vickery?"

"Well . . . yes . . . but—"

"You seem to have forgotten for the moment that the choths have been no more unanimous than your human factions," Liaw said. "Believe me, they have been divided and they are. Though a majority voted for the latest defense measures, a vocal minority has opposed: feeling, as you do, President Vickery, that the danger has been exaggerated and does not justify lifting that great a load."

Liaw sat silent for a space, during which the rest of them heard wind whistle behind him and saw a pair of his grandsons fly past. One bore the naked sword which went from house to house as a summons to war, the other a blast rifle.

The High Wyvan said: "Three choths refused to make their gift. My fellows and I threatened to call Oherran on them. Had they not yielded, we would have done so. We consider the situation to be that grave."

Holm choked. *He never told me before! Of course, he wouldn't have.* Ferune grew nearly as still on his bench as Liaw. Vickery drew breath; sweat broke out on his smoothness; he dabbed at it.

I can almost sympathize, Holm thought. *Suddenly getting bashed with reality like that.*

Matthew Vickery should have stayed a credit analyst instead of going into politics (Holm's mind rambled on, at the back of its own shocked alertness). Then he'd have been harmless, in fact useful; interspecies economics is often a wonderland in need of all the study anyone can give it. The trouble was, on a thinly settled globe like Avalon, government never had been too important aside from basic issues of ecology and defense. In recent decades its functions had dwindled still further, as human society changed under Ythrian influence. (A twinge of pain.) Voting was light for offices that looked merely managerial. Hence the more reactionary humans were able to elect Vickery, who viewed with alarm the trend toward Ythrianization. (Was no alarm justified?) He had nothing else to offer, in these darkening times.

"You understand this is confidential," Liaw said. "If word got about, the choths in question would have to consider it a deathpride matter."

"Yes," Vickery whispered.

Another silence. Holm's cigar

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had burned short, was scorching his fingers. He stubbed it out. It stank. He started a new one. *I smoke too much,* he thought. *Drink too much also, maybe, of late. But the work's getting done, as far as circumstance allows.*

Vickery wet his lips. "This puts another complexion on affairs, doesn't it?" he said. "May I speak plainly? I must know if this is a hint that ... you may come to feel yourselves compelled to a *coup d'état*."

"We have better uses for our energies," Liaw told him. "Your efforts in Parliament could help."

"Well, you realize I can't surrender my principles. I must be free to speak."

"It is written in the Compact," Fortune said, and his quotation did not seem superfluous even by Ythrian standards, "'Humans inhabiting Avalon have the deathpride right of free speech, publication, and broadcast, limited only by the deathpride rights of privacy and honor and by the requirements of protection against foreign enemies.'"

"I meant ..." Vickery swallowed. But he had not been years in politics for nothing. "I meant simply that friendly criticism and suggestions will always be in order," he said with most of his accustomed ease. "However, we certainly cannot risk a civil war. Shall we discuss details of a policy of nonpartisan cooperation?"

Behind the ready words, fear could still be sensed. Holm imagined he could almost read Vickery's mind, reviewing the full significance of what Liaw had said.

How shall a fierce, haughty, intensely clannish and territorial race regulate its public business?

Just as on Terra, different cultures on Ythri at different periods in their histories have given a variety of answers, none wholly satisfactory or permanently enduring. The Planha speakers happened to be the most wealthy and progressive when the first explorers arrived; one is tempted to call them "Hellenistic." Eagerly adopting modern technology, they soon absorbed others into their system while modifying it to suit changed conditions.

This was the easier because the system did not require uniformity. Within its possessions—whether these were scattered or a single block of land or sea—a choth was independent. Tradition determined what constituted a choth, though this was a tradition which slowly changed itself, as every living usage must. Tribe, anarchism, despotism, loose federation, theocracy, clan, extended family, corporation, on and on through concepts for which there are no human words, a choth ran itself.

Mostly, internal ordering was by custom and public opinion rather than by prescription and force. Af-

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ter all, families rarely lived close together; hence friction was minimal. The commonest sanction was a kind of *weregild*, the most extreme was enslavement. In between was outlawry; for some specified period, which might run as high as life, the wrongdoer could be killed by anyone without penalty, and to aid him was to incur the same punishment. Another possible sentence was exile, with outlawry automatic in case of return before the term was up. This was harsh to an Ythrian. On the other hand, the really disaffected could easily leave home (how do you fence in the sky?) and apply for membership in a choth more to their taste.

Now of course some recognized body had to try cases and hand down judgments. It must likewise settle interchoth disputes and establish policies and undertakings for the common weal. Thus in ancient times arose the Khruath, a periodic gathering of all free adults in a given territory who cared to come. It had judicial and limited legislative authority, but no administrative. The winners of lawsuits, the successful promoters of schemes and ordinances, must depend on willingness to comply or on what strength they could muster to enforce.

As Planha society expanded, regional meetings like this began to elect delegates to Year-Khruaths, which drew on larger territories. Finally these, in turn, sent their representatives to the High Khruath of the whole planet, which met every six years plus on extraordinary occasions. On each level, a set of presiding officers, the Wyvans, were chosen. These were entrusted with explication of the laws (that is, customs, precedents, decisions) and with trial of as many suits as possible. It was not quite a soviet organization, because any free adult could attend a Khruath on any level he wished.

The arrangement would not have worked on Terra—where a version of it appeared once, long ago, and failed bloodily. But Ythrians are less talkative, less busybody, less submissive to bullies, and less chronically crowded than man. Modern communications, computers, information retrieval, and educational techniques helped the system spread planetwide, ultimately Domain-wide.

Before it reached that scale, it had had to face the problem of administration. Necessary public works must be funded; in theory the choths made free gifts to this end, in practice the cost required allocation. Behavior grossly harmful to the physical or social environment must be enjoined, however much certain choths might profit by it or regard it as being of their special heritage. Yet no machinery existed for compulsion, nor would Ythrians have imagined establishing any—as such.

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It was all it came slowly about that when a noncompliance looked important the Wyvans of the appropriate Khruath cried Oherran on the offenders. This, carried out after much soul-searching and with the gravest ceremonies, was a summons to everyone in the territory: that for the sake of their own interests and especially their honor, they should defy the defiers of the court.

In early times, an Oherran on a whole often meant the end of it—banishment of whoever had not been slaughtered, division of holdings among the victors. Later it might amount to as little as the arrest and exile of named leaders. But always it fell under the concept of deathpride. If the call to Oherran was rejected, as had happened when the offense was not deemed grave enough to justify the monstrosity of invasion, then the Wyvans who rose had no acceptable alternative but suicide.

Of course, the Ythrian character, Oherran works about as well as police among men. If your society has lost morale, human, how often must you call the police?

None who knew Liaw of The Lair imagined he would untruthfully say that he had threatened to rip Avalon asunder.

VI

Where the mighty Sagittarius flows into the Gulf of Centaurs, Avalon's second city, the only one besides Gray which rated the name—had arisen as riverport, seaport, spaceport, industrial center, and mart. Thus Centauri was predominantly a human town, akin to many of the Empire, thronged, bustling, noisy, cheerfully corrupt, occasionally dangerous. When he went there, Arinnian most of the time had to be Christopher Holm, in behavior as well as name.

Defense business now required it. He was not astonished at becoming a top officer of the West Coronan home guard, after that took its loose shape—not in a society where nepotism was the norm. It did surprise him that he seemed to be doing rather well, even enjoying himself in a grim fashion, he who had always scoffed at the "herd man." In a matter of weeks he got large-scale drills going throughout his district and was well along on the development of doctrine, communications, and supply. (Of course, it helped that most Avalonians were enthusiastic hunters, often in large groups on battues; and that the Troubles had left a military tradition not difficult to revive; and that old Daniel was on hand to advise.) Similar organizations had sprung up everywhere else. They needed to coordinate their efforts with the measures being taken by the Seamen's Brotherhood. A conference was called. It worked hard and accomplished as many of its purposes as one could reasonably hope.

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Afterward Arinnian said, "Hrill, would you like to go out and celebrate? W-we may not have a lot more chances." He did not speak on impulse. He had debated it for the past couple of days.

Tabitha Falkayn smiled. "Sure, Chris. Everybody else will be."

They walked down Livewell Street. Her arm was in his: in the subtropical heat he was aware of how their skins traded sweat. "I . . . well, why do you generally call me by my human name?" he asked. "And talk Anglic to me?"

"We are humans, you and I. We haven't feathers to use Planha as it ought to be used. Why do you mind?"

For a moment he floundered. *That personal a question . . . an insult, except between the closest friends, when it becomes an endearment . . . No, I suppose she's just thinking human again.* He halted and swept his free hand around. "Look at that and stop wondering," he said. Instantly he feared he had been too curt.

But the big blond girl obeyed. This part of the street ran along a canal, which was oily and littered with refuse, burdened with barges, walled in by buildings jammed together, whose dingy façades reared ten or twelve stories into night heaven. Stars and the white half-disk of Morgana were lost behind the glare, blink, leap and worm-crawl of raw-colored signs. (GROG HARBOR, DANCE, EAT, GENUINE TERRAN SENSIES, FUN HOUSE, SWITCH TO MARIA JUANAS, GAMBLING, NAKED GIRLS, LOANS, BUY . . . BUY . . . BUY . . .) Groundbugs filled the roadway, pedestrians the sidewalks, a sailor, a pilot, a raftman, a fisher, a hunter, a farmer, a whore, a secretary, a drunk about to collapse, another drunk getting belligerent at a monitor, a man gaunt and hairy and ragged who stood on a corner and shouted of some obscure salvation, endless human seething, shrilling, chattering, through engine rumble, foot shuffle, raucousness blared out of loudspeakers. The air stank, dirt, smoke, oil, sewage, flesh, a breath from surrounding swamplands, which there would have been a clean rotting but here was somehow made nasty.

Tabitha smiled at him anew. "Why, I call this fun, Chris," she said. "What else've we come for?"

"You wouldn't—" he stammered. "I mean, somebody like you?"

He realized he was gaping at her. Both wore thin shortsleeved blouses, kilts, and sandals; garments clung to wet bodies. But despite the sheen of moisture and the odor of female warmth that he couldn't help noticing, she stood as a creature of sea and open skies.

"Sure, what's wrong with once-in-a-while vulgarity?" she said, still amiable. "You're too puritan, Chris."

"No, no," he protested, now

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afraid she would think him naïve. "Fastidious, maybe. But I've often been here and, uh, enjoyed myself. What I was trying to explain was, uh, I. I'm proud to belong to a choth and not proud that members of my race elect to live in a sty. Don't you see, this is the old way, that the pioneers wanted to escape."

Tabitha said a word. He was staggered. Eyath would never have spoken thus. The girl grinned. "Or, if you prefer, 'nonsense,'" she continued. "I've read Falkayn's writings. He and his followers wanted not one thing except unmolested elbow room." Her touch nudged him along. "How about that dinner we were aimed at?" Numbly, he moved.

He recovered somewhat in the respectable dimness of the Phoenix House. Among other reasons, he admitted to himself, the room was cool and her clothes didn't emphasize her shape as they did outside.

The place had live service. She ordered a catflower cocktail. He didn't. "C'mon," she said. "Unbuckle your shell."

"No, thanks, really." He found words. "Why dull my perceptions at a happy moment?"

"Seems I've heard that line before. A Stormgate saying?"

"Yes. Though I didn't think they use drugs much in Highsky either."

"They don't. Barring the sacred revels. Most of us keep to the Old Faith, you know." Tabitha regarded him a while. "Your trouble, Chris, is you try too hard. Relax. Be more among your own species. How many humans do you have any closeness to? Bloody-gut few, I'll bet."

He bridled. "I've seen plenty of late."

"Yeah. And emergency or no, doesn't it feel good? I wouldn't try to steer somebody else's life, of course, nor am I hinting it's true of you—but fact is, a man or woman who tries to be an Ythrian is a rattlewing."

"Well, after three generations you may be restless in your choth," he said, gauging his level of sarcasm as carefully as he was able. "You've knocked around quite a bit in human country, haven't you?"

She nodded. "Several years. Itinerant huntress, trapper, sailor, prospector, over most of Avalon. I got the main piece of my share in the stake that started Draun and me in business—I got that at assorted poker tables." She laughed. "Damn, sometimes it is easier to say things in Planha!" Serious: "But remember, I was young when my parents were lost at sea. An Ythrian family adopted me. They encouraged me to take a wandertime; that's Highsky custom. If anything, my loyalty and gratitude to the choth were strengthened. I simply, well, I recognize I'm a member who happens to be human. As such, I've things to offer

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which." She broke off and turned her head. "Ah, here comes my drink. Let's talk trivia. I do get starved for that on St. Li."

"I believe I will have a drink too," Arinnian said.

He found it helpful. Soon they were cheerily exchanging reminiscences. While she had doubtless led a more adventurous life than he, his had not been dull. On occasion, such as when he hid from his parents in the surf-besieged Shielding Islands, or when he had to meet a spathodont on the ground with no more than a spear because his companion lay wing-broken, he may have been in worse danger

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than any she had met. But he found she was most taken by his quieter memories. She had never been offplanet, except for one vacation trip to Morgana. He, son of a naval officer, had had ample chances to see the whole Lauran System from sun-wracked Elysium, through the multiple moons of Camelot, out to dark, comet-haunted Utgard. Speaking of the frigid blue peace of Phaeacia, he chanced to quote some Homeric lines, and she was delighted and wanted more and asked what else this Homer fellow had written, and the conversation turned to books . . .

The meal was mixed, as cuisine of both races tended increasingly to be: piscoid-and-tomato chowder, beef-and-shua pie, salad of cluster-grain leaf, pears, coffee spiced with witchroot. A bottle of vintage dago gave merriment. At the end, having seen her indulge the vice before, Arinnian was not shocked when Tabitha lit her pipe. "What say we look in on the Nest?" she proposed. "Might find Draun." Her partner was her superior in the guard; she was in Centauri as his aide. But the choth concept of rank was at once more complex and more flexible than the Technic.

"Well . . . all right," Arinnian answered.

She cocked her head. "Reluctant? I'd've guessed you'd prefer the Ythrian hangout to anyplace else in town." It included the sole public house especially for ornithoids, they being infrequent here.

He frowned. "I can't help feeling that tavern is wrong. For them," he added in haste. "I'm no prude, understand."

"Yet you don't mind when humans imitate Ythrians. Uh-uh. Can't have it on both wings, son." She stood. "Let's take a glance into the Nest boozeria, a drink if we meet a friend or a good bard is reciting. Afterward a dance club, hm-m-m?"

He nodded, glad—amidst an accelerating pulse—that her mood remained light. While no machinery would let them take part in the Ythrian aerial dances, moving across a floor in the arms of another bird was nearly as fine, perhaps. And, while that was as far as such contact had ever gone for him, maybe Tabitha—for she was indeed Tabitha on this steamy night, not Hrill of the skies . . .

He had heard various muscular oafs talk of encounters with bird girls, less boastfully than in awe. To Arinnian and his kind, their female counterparts were comrades, sisters. But Tabitha kept emphasizing his and her humanness.

They took a taxibug to the Nest, which was the tallest building in the city, and a gravshaft to its rooftop since neither had brought flying gear. Unwalled, the tavern was protected from rain by a vitryl canopy through which, at this height,

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stars could be seen regardless of the electric lunacy below. Morgana was sinking toward the western bottomlands, though it still silvered river and Gulf. Thunderheads piled in the east, and a rank breeze carried the mutter of the lightning that shivered in them. Insectoids circled the dim fluoroglobe set on every table. Business was sparse, a few shadowy forms perched on stools before glasses or narcobraziers, a service robot trundling about, the recorded twangs of a steel harp.

"Scum-dull," Tabitha said, disappointed. "But we can make a circuit."

They threaded among the tables until Arinnian halted and exclaimed, "Hov-ah! Vodan, ekhhirr."

His chothmate looked up, plainly taken aback. He was seated at drink beside a shabby-plumed female who gave the newcomers a sullen stare.

"Good flight to you," Arinnian greeted in Planha; but what followed, however automatic, was too obvious for anything save Anglic. "I didn't expect to find you here."

"And to you, good landing," Vodan replied. "I report to my ship within hours. My transport leaves from Halcyon Island base. I came early so as not to risk being detained by a storm; we've had three whirldevils in a row near home."

"You are vare for battle, hunter," said Tabitha at her most carefully courteous.

That's true, Arinnian thought. *He's ablaze to fight. Only . . . if he couldn't stay with Eyath till the last minute, at least I'd've supposed he'd've been in flight-under-moon, meditating—or, anyhow, at carouse among friends . . .* He made introductions.

Vodan jerked a claw at his attendant. "Quenna," he said. His informality was casual insult. She hunched between her wings, feathers erected in an attitude of forlorn self-assertion.

Arinnian could think of no excuse not to join the party. He and the girl seated themselves as best they could. When the robot rolled up, they ordered thick, strong New African beer.

"How blows your wind?" Tabitha asked, puffing hard on her pipe.

"Well; as I would like for you," Vodan answered correctly. He turned to Arinnian and, if his enthusiasm was a touch forced, it was nonetheless real. "You doubtless know I've been on training maneuvers these past weeks."

Yes. Eyath told me more than once.

"This was a short leave. My craft demands skill. Let me tell you about her. One of the new torpedo launchers, rather like a Terran Meteor, hai, a beauty, a spear! Proud I was to emblazon her hull with three golden stars."

"Eyath" means "Third Star."

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Vodan went on. Arinnian glanced at Tabitha. She and Quenna had locked their gazes. Expressions billowed and jerked across the feathers; even he could read most of the unspoken half-language.

Yes, m'sweet, you long yellow Walker born, Quenna is what she is and who're you to look down that jutting snout of yours? What else could I be, since I, growing from cub to maiden, found my lovetimes coming on whenever I thought about 'em and knew there'd never be any decent place for me in the whole universe? Oh, yes, yes, I've heard it before, don't bother: "medical treatment; counseling." Well, flabbyflesh, for your information, the choths don't often keep a weakling, and I'll not whine for help. Quenna'll lay her own course, better'n you, who're really like me . . . aren't you, now, she-human?

Tabitha leaned forward, patted one of those arms with no heed for the talons, smiled into the reddened eyes and murmured, "Good weather for you, lass."

Astounded, Quenna reared back. For an instant she seemed about to fly at the girl, and Arinnian's hand dropped to his knife. Then she addressed Vodan: "Better we be going."

"Not yet." The Ythrian had fairly well overcome his embarrassment. "The clouds alone will decide when I see my brother again," he said.

"We better go," she said lower. Arinnian caught the first slight musky odor. At the next table, another male raised his crest and swiveled his head in their direction.

Arinnian could imagine the conflict in Vodan—dismiss her, defy her, strike her; no killing, she being unarmed—and yet that would be a surrender in itself, less to tradition than to mere conventionality. "We'll have to leave ourselves, soon's we finish these beers," the man said. "Glad to've come on you. Fair winds forever."

Vodan's relief was unmistakable. He mumbled through the courtesies and flapped off with Quenna. The city swallowed them.

Arinnian wondered what to say. He was grateful for the dull light; his face felt hotter than the air. He stared outward.

Tabitha said at length, softly, "That poor lost soul."

"Who, the nightflyer?" All at once he was furious. "I've met her sort before. Degenerates, petty criminals. Pray Vodan doesn't get his throat cut in whatever filthy crib she's taking him to. I know what must've happened here. He was wandering around lonely, at loose ends, a mountaineer who'd probably never come on one like her. She zeroed in, hit him with enough pheromone to excite him—ugh!"

"Why should you care? I mean,

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of course he's a friend of yours, but I hardly believe that pathetic creature will dare try more than wheedling a tip out of him." Tabitha drank smoke. "You know," she said thoughtfully, "here's a case of Ythrian cultural lag. They've been affected by human ideas to the point where they don't give their abnormals a quick death. But they're still not interested in sponsoring rehabilitation or research on cures, or in simple charity. Somebody—"

He scarcely heard the last remark. "Vodan's to marry Eyath," he said through the interior grip on his gullet.

Tabitha raised her brows. "Oh? That one you mentioned to me? Well, don't you suppose, if she heard, she'd be glad he's gotten a bit of unimportant fun and forgetting?"

"It's not right! She's too clean. She—" Arinnian gulped. Abruptly he thought. *So why not take the risk? Now I need forgetting myself.* "Is the matter small to you?" he blurted. "In that case, let's us do the same."

"Hm-m-m?" She considered him for a while that grew. Lightning moved closer on heavy gusts. His rage ebbed and he must fight not to lower his eyes, not to cringe.

At last: "You are bitter for certain, aren't you, Chris?" A chuckle. "But likewise you're hopeful."

"I'm sorry," he got out. "I n-n-never meant disrespect. I wanted to give you a, an imaginary example—make you understand why I'm upset."

"I might resent your calling it imaginary," she smiled, though her tone had become more compassionate than teasing, "except I assume it wasn't really. The answer is no, thanks."

"I expected that. We birds—" He couldn't finish, but stared down into his mug until he lifted it for a quick, deep draught.

"What d'you mean, 'we'?" she challenged.

"Why, we . . . our generation, at least—"

When she nodded, her locks caught what illumination there was. "I know," she said gravely. "That behavior pattern, promiscuous as kakkelaks provided they don't much respect their partners, but hardly able to touch birds of the opposite sex. You're a bright lad, Chris; Avalonians aren't given to introspection, but you must have some idea of the cause. Don't you want a wife and children, ever?"

"Of course. I—of course. I will."

"Most of them will, I'm sure. Most of the earlier ones did eventually, when they'd come to terms with themselves. Besides, the situation's not universal. We birds do have this in common, that we tolerate less prying than the average human. So comparative statistics aren't available. Also, the problem has gotten conspicuous these days

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for no deeper reason than that the movement into the choths has begun snowballing. And, finally, Chris, your experience is limited. How many out of thousands do you know well enough to describe their private lives? You'd naturally tend to be best acquainted with your own sort, especially since we birds have gotten pretty good at picking up face and body cues."

Tabitha's pipe had gone out. She emptied it and finished: "I tell you, your case isn't nearly as typical as you think, nor nearly as serious. But I do wish that going bird didn't make otherwise sensible people lose years in thwarting themselves."

Anger pricked him again. What call had she to act superior? "Now wait—" he began.

Tabitha knocked back her beer and rose. "I'm headed for my hotel," she said.

He stared up at her. "What?"

She ruffled his hair. "I'm sorry. But I'm afraid if we continue tonight, we'll brew one cyclone of a squabble. I think too well of you to want that. We'll take another evening soon if you like. Now I aim to get into bed and have Library Central screen me some of that Homer stuff."

He couldn't dissuade her. Perhaps he took most umbrage at how calm his arguments left her. When he had bidden her a chill goodnight, he slouched to the nearest phoneboard.

The first woman he called was at work. Defense production was running at seven hours on, fifteen and the odd minutes off, plus overtime. The second female acquaintance said frantically that her husband was home if that was the party he wanted; he apologized for punching a wrong number. The third was available. She was overly plump, chattered without cease, and had the brains of a barysauroid. But what the chaos?

He awoke about the following sunset. She was sweating in her sleep, breath stale from alcohol. He wondered why the air had gone hot and sticky. Breakdown in the conditioner? Or, hm-m-m, it'd been announced that if force screens must be raised, the power drain would require Environmental Control to shut off—

Force screens!

Arinnian jumped from bed. Rain had given way to low overcast, but he glimpsed shimmers across that slatiness. He groped through the dusty clutter in the room and snapped on the holovid.

A recording played, over and over, a man's voice high-pitched and his face stretched out of shape: "—war declared. A courier from Ythri has delivered the news in Gray, that Terra has served notice of war."

TO BE CONTINUED

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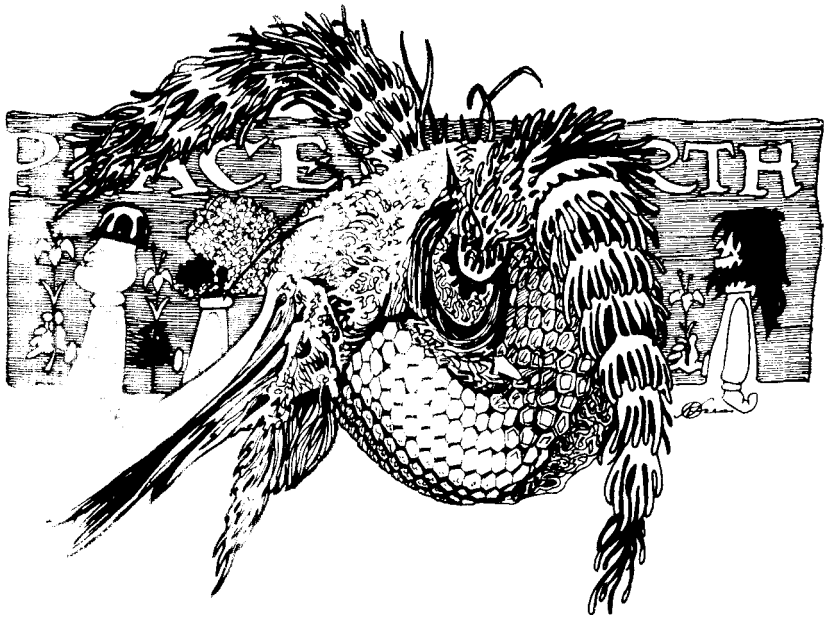

W. MACFARLANE

BIOLOGICAL

Sometimes a demonstration can be unexpectedly successful. And when it is, the need for such demonstrations disappears—even though something else will soon be "bugging" the demonstrators.

PEACEFARE

KELLY FREAS

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Wilbur Hines was pushed against the reinforced glass of the laboratory by the mob. "You are making a mistake," he said. His face was red-lined by fingernails. His wire-rim glasses hung from one ear. "Nothing but bugs in there."

"Bi-o-log-i-cal swine," said a vivid girl with a baseball bat. Her color was high, her eyes snapping.

"No-no, you mustn't go in there," said Hines, rehooking his glasses. "I'm studying *Platyura fultoni* and *Chironomus plumosus* and twenty-eight other kinds of gnats. You look like a nice girl. Why don't you go have your demonstration someplace else? The draft board maybe, the president's office—"

"Bac-ter-io-log-i-cal pig!" She jumped onto a chair. "Dump the files! Get with those prybars! They spend our money like water to contaminate the world while people starve! We'll show these scientific chauvinists—smash that door!"

"You are not thinking this thing through," said Hines. "Pandora opened a box and—"

"My name's Monica." She tapped him on the side of the head, changed hands like a switch-hitter and smashed the bat into the glass. Hines slumped to the floor. He was dazed. His head hurt. He opened one eye to look at his wristwatch and put his fingers on his pulse. He counted. The girl had opened a box of troubles—Pandora—but he was more surprised at his own uncharacteristic flight of fancy. A real smasher, that girl. He counted to sixty-two—up eight beats a minute from normal. He shut his eyes. When the laboratory was reduced to shambles he shook off the glass shards and picked his way through the mess to notify the authorities.

A dear little man with quiet brown eyes and a perky hat on the back of his head but unworldly—misguided and warped by the bitch goddess Science—so until man learns humanity the end must justify the means and if it doesn't, what does?

Sergeant McCann asked, "Were the bugs poisonous, Dr. Hines?"

"Not in the United States." Hines gingerly rubbed the lump above his ear. "*Phlebotomus* is the disease vector. The verruga or Oroya fever, which occurs in Peru, Ecuador, Bolivia and other South American countries, is carried by sand flies. They also transmit pappataci fever and kala azar, a leishmaniasis endemic in the Mediterranean area—"

"My god, Doc—"

"I am not studying sand flies." He eased his hat onto the back of his head. "No-see-ums and related species are miscalled sand flies and also punkies, but they're properly *Culicoides,* which is certainly not the same as *Phlebotomus.*"

"Right. Now tell me true—is this biological warfare?"

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"No-no. My research is federally funded but I hold the grant and Snohomish University provides the facilities—"

"I better call the F.B.I. How about all that weird machinery they busted. Any of that dangerous?"

"The ultraviolet rays are produced by a mercury arc enclosed in quartz, emitting wavelengths from 2,400 to 4,350 angstrom units. The ultrasonic generator has four transducer assemblies with a maximum input of 300 milliamps and 1,800 volts or 540 watts—"

McCann sighed. He often told his wife that police work was a pleasure except for the people. "Now, Doc," he interrupted, "how about the bugs they busted loose? Any problem there?"

"No," said Hines, but he was wrong.

The heart must rule but the head should help and this incitement to riot bit is ridiculous and the media is not with us and I'm tired of skulking—is it worth the heartbreak when others fink—and my scholarship—what shall I do!

The exact conditions of the mutation were never established. There were too many variables. Little research had been done on gnats and the idea of an adaptable species was rejected time and again by early investigators. It was a warm spring and a warm, wet summer. The more heated the arguments, the more often the new gnats bit. The outdoor graduation program was totally disrupted.

"Got a bad connection," said Fennimore, the agent in charge of the Seattle F.B.I. office. "Yes, we're working on the vandalism—but what's this about Nazis?" Because it was a lovely day and his case load was light, he drove the twenty miles to Snohomish University. "Darn!" he said, "those little fellas do sting! Darn-darn!" He teletyped the regional supervisor, who scoffed but came to be bitten. The news went to Washington D.C. and the Bureau of Entomology and Plant Quarantine forwarded a pair of experts who called in others to be stung while the F.B.I. reclassified the laboratory destruction to priority status and rounded up every one of the rioters. They were questioned at the University.

"Ow!" said Monica. "Des-picable fuzz! Ouch!"

Sure, every switch had been turned on and the controls twisted off before the bug cages were smashed. Yeah-yeah, the vacuum tube was going, the one producing X-rays by impinging high-velocity electrons against platinum. There was arcing from electric motors, freon from broken compressor tubes, destruction of all bottles of chemicals and insecticides, the fire extinguisher was squirted on the control panels, the bug foggers turned high, the laboratory mice set free. What else was new?

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"Cruel and unusual punishment!" screamed Monica. "Bitten to death by bugs! Ow-ow-ow!"

Wilbur Hines chose not to join the illustrious company of Captain Boycott, Thomas Bowdler and Vidkun Quisling. He did not call the new species after himself but named it *Culicoides snohomish* and recommended drastic control measures. The state and U.S.D.A. entomologists did not agree until they encountered *snohomish* personally, and the delay allowed a group of distant ecology enthusiasts to halt the abatement program by court order until it was too late.

"I don't account for them," said Dr. Hines. "The larvae of the North Carolina fungus gnat glow at either end and the adult European midge is luminous. There is no precedent for the minute chartreuse spark at the tail of the new species. The calypter is small and inconspicuous and the mesonotal suture incomplete, which is common in eye gnats, pomace or vinegar flies, but the wings are silent in flight. This mutation is a whole new ball game," he said, "because *snohomish* likes human beings."

There was a spring brood, an early summer brood, a summer brood of astonishing size, and a supplementary fall brood. Seattle International Airport was a distribution point to the entire world. *Snohomish* found tweeds and hatbands and skirt hems a natural habitat. The insects were not affected by fumigation procedures current at the time because airplanes were aerosoled empty, and when the passengers arrived in London or Tokyo or Calcutta, the gnats established themselves in woolens or obis or turbans.

We would have been hung in Seattle without the change of venue because there's no escaping the beastly bugs but the restitution the court ordered is slavery and un-American and I don't see how his hat stays on the back of his head—

Data accumulated slowly while *snohomish* was consolidating its position rapidly in an unoccupied ecological niche. Aerial trapping produced specimens up to eleven thousand feet in turbulent conditions. The gnats were observed breeding in a warm spring on the side of Mt. Shasta at a temperature of 122 degrees. *Snohomish* overwintered with great success and became active at five degrees above freezing. The larvae thrived in either fresh or salt water though the mineral content of the Great Salt Lake killed them. The next summer, at Clear Lake, California, eighty-five pounds of gnats were collected overnight in a suction trap, attracted by an electric light. There were a million insects to the pound.

"How do you crystal-ball the situation?" said Gilroy, a fact-finder for the President.

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"Well, sir," said Hines, "man has killed some dozens of animal species, but bugs have been around for two hundred and fifty million years. Not one species has ever disappeared because of man's efforts."

"O.K., but feasibility studies say that *snohomish* could be wiped out just as the Mediterranean fruit fly was exterminated in Florida, the gypsy moth date scale was destroyed in Arizona, California and Texas, the brown-tail moth eradicated from Nova Scotia and New Brunswick, and dozens of other examples." Gilroy folded his notes.

"The primary host has not been mate," said Hines. "We are the preferred feeding ground and some of us are more attractive than others. Fleas illustrate a similar preference. So far, we have found no repellent that is not overridden by human secretions in conditions of stress."

"Insecticides?"

"When DDT gets on an insect's body, it affects hundreds of sensory nerve endings which then produce impulses faster and stronger than normal. It further increases the consumption of oxygen and decreases the amount of stored food substances in the body. With the central nervous system disrupted, the ordinary insect dies. But *snohomish* demonstrates an unexampled tolerance and becomes more active with anything less than total lethal coverage. It responds to minimum emotional output and feeds voraciously."

"Come on now, Doc," said Gilroy, "is this proven?"

"The F.B.I. made polygraphs available—lie detectors—which give a data base to general observation. We do not understand the process in any depth. Whether adrenaline, muscular tension or electrical conductivity triggers the response is unknown. My prime example is a hyperemotional female lab assistant. When a *snohomish* is released in a crowded room, it invariably bites her."

"Recommendations?"

"I have a hunch about radiant energy. In the meantime, keep calm."

I am a dolorous guinea pig—the bugs love me—the new ointment soothes the bite after it stings like mad and I suppose since I have this talent and cannot go outdoors I might as well bask in the sun-lamp room in my new bikini or without it—and maybe buzz and bite Dr. Wilbur Hines—

Subspecies developed in adaptation to local conditions around the world. In India the luminescence at the tail was clear topaz and in north China a dull pink shaded to yellow in the south. The European species had a blue spark shifting to orange in Sicily and to lavender in Africa. The gnats were small enough to crawl through a fine mesh screen and the mutated wings were silent except just prior to

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feeding. The sudden buzz was psychologically devastating.

A thousand control measures were tried.

"I mash garlic and spread a paste on my hands and face."

"Try citronella mixed with oil of peppermint."

"Mud works."

Toad & Gecko franchise stores covered the country. "Nature's Way" was their motto and they sold everything from flycatchers to mosquito fish to swimming pool oil. "Raise bats for fun and profit in the comfort and convenience of your own attic or basement."

The sex lures successful with other insects failed with *snohomish* and the recorded mating calls only increased the gnat population. When sterile males were released they devoted all their time to feeding instead of mating. *Snohomish* was susceptible to no known disease such as foulbrood among bees or various bacteria and fungi that affect silkworms and grasshoppers. Lead arsenate in large concentrations was effective as were the organic phosphates, but they were also deleterious to warm-blooded animals.

During the second summer of the *snohomish* era, the light trap that harvested eighty-five pounds of gnats attracted the phototropic elements of the spring brood, and afterwards caught only the casual passersby of the swarms.

The U.S. government devoted twenty billion dollars to reconstruction and air pumps. This sum was estimated to be one fifth of the money spent privately to pressurize homes and build entries where clothes could be fumigated and showers taken before entering the insect-free rooms. A four-pound pressure differential was sufficient, and gnat filters for the pumps were stocked everywhere.

There was no mass rioting in tropical countries where *snohomish* flourished year round. Silent mobs gathered and dispersed when the first rock was thrown. The charisma of leadership and response was impossible when gnats would gather to feed as surely as death and taxes. Protective clothing had drawbacks. A calm photographer got a memorable shot of a dozen men dead of heat prostration wrapped in plastic in Karachi. In the Asian countries where running amok was a cultural phenomena, those men so inclined were wiped out in the first six months. No hunter could hunt, no excitable fisherman could fish, no farmer could curse the lack of rain.

So it's peace forever—and the torpid shall inherit the earth—what price do you pay for peace—fear and anger—and joy—I wonder, now I wonder—

Infantry could wear refrigerated protective clothing and it was possible to seal off tanks and air-

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planes. But land could not be held by artificially supported troops. It was possible to campaign at temperatures below thirty-seven degrees, but arguments over the Greenland icecap were futile. The gnats flourished wherever man flourished and logistical problems of marginal geography were not worth the trouble.

And every individual faced an intense personal crisis.

The universal entertainment of mankind, procreation, became so odious that in the poor countries the population curve broke and fell at a ninety-degree slope. Even Latin American *machismo* could not withstand the sudden buzzing attack of *snohomish*. Rich engineers built gnat-free recreation parlors and alarmed governments built enormous warrens for single intercourse. The general fertility rate in the United States—the number of births per 1,000 females aged 15 to 45—was 87.6 in 1971. A decade later it was 45.3 in the most technologically advanced nation in the world. The baby boom after World War II led demographers to project an enormous population growth. *Snohomish* bit the air out of that balloon. Even the two percent of the population unpalatable to gnats under normal conditions were gourmet food in sexual congress.

No Shakespeare festivals, no football games—no sublimation of the raunchy human spirit—it is anguish to read a lyric poet on a windy hill—yet I am coming to understand sober delight—I of all people walked in alpha security today in the sunshine—

Bio-feedback training swept the nation. The internal conditions and rhythms of the body are translated by powerful amplifiers into light or sound or fluctuations of a needle, enabling most people to learn conscious control of unconscious phenomena like blood pressure, skin temperature, muscle tension and glandular secretion. Brain wave patterns showed that creative and problem-solving thought produced theta waves, and the beta rhythm of anxiety and intense concentration was equally attractive to *snohomish*. Zen

■ **THE ANALYTICAL LABORATORY** / NOVEMBER 1972

	AUTHOR	POINTS
[illegible] (Pt. 1)	*Clifford D. Simak*	*1.28*
[illegible]	*Jim Durham*	*2.64*
[illegible]	*Jesse Miller*	*3.71*
[illegible] the Assassin Merefirs [illegible] the First Part	*Ken W. Purdy*	*4.46*
[illegible]	*Richard F. DeBaun*	*4.68*
[illegible] Proposal	*C. N. Gloeckner*	*5.14*
	Anthony R. Lewis	*5.58*

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and yoga masters produced alpha waves in meditation, and were ignored by the gnats. Wave-pattern schools became a way of life, encouraged by the yoga claim of six-hour continuous intercourse once a month.

Dr. Wilbur Hines was among the two percent unaffected by *snohomish.* He was not excited when the National Gnat Studies Center in Bougaloosa, Louisiana devoted more and more of its budget to psychosomatics and quietly continued his research on reduced funding. When his wife Monica was of no further use as a gnat target, she traveled extensively. She sent him postcards.

Cairo. Bilharziasis eradicated as by-product of Israeli entomological research–odd to remember these Semites at odds–

Rome. Men no longer pinch bottoms and the Pope's example is laughed at–gently–his wife is reported to be a fecund shrew–

London. The control naturals have committed mass suicide after a farewell orgy and I say we are well rid of them–

Moscow. Arctic studies group disbanded–too exciting–why not live quietly like human beings they said–

Peking. The gnat is the latterday manifestation of the dragon–interior rather than of the external world–funny people–

Tokyo. Alpha imprinter not successful–they call the meditation chambers "decontamination" after research work–

Manila. TV station occupied by protected police after running Tarzan film–too provocative–

Honolulu. Babies seem to learn quickly–unions accepting whites on equal basis–amazing–

When she returned to Snohomish University, her husband asked if she had a nice trip and mentioned later that he had found a way to kill the gnats. He took her to the laboratory and demonstrated neural destruction programmed onto radio carrier waves. "At the intersection of two transmission sources the insects are scrambled, effectually heated to death."

"What happens if you suppress this discovery?"

"Maybe, just maybe, someone else will make it."

"Do you know–I like it this way."

"I'd better continue my work to develop a jamming wave."

"Yes darling," she said, "got to protect our bugs."

Rage and terror so attractive–pitched too high for us today–wild goat cries how wonderful to learn again transposed–will man be less or more than man–how grandiose to make such a decision yet I am personally bitten–or are the bugs indeed the bugs of God–the future has always been anomalous–what's to hazard–let's try it this way a while. ■

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THE GUY WITH THE EYES

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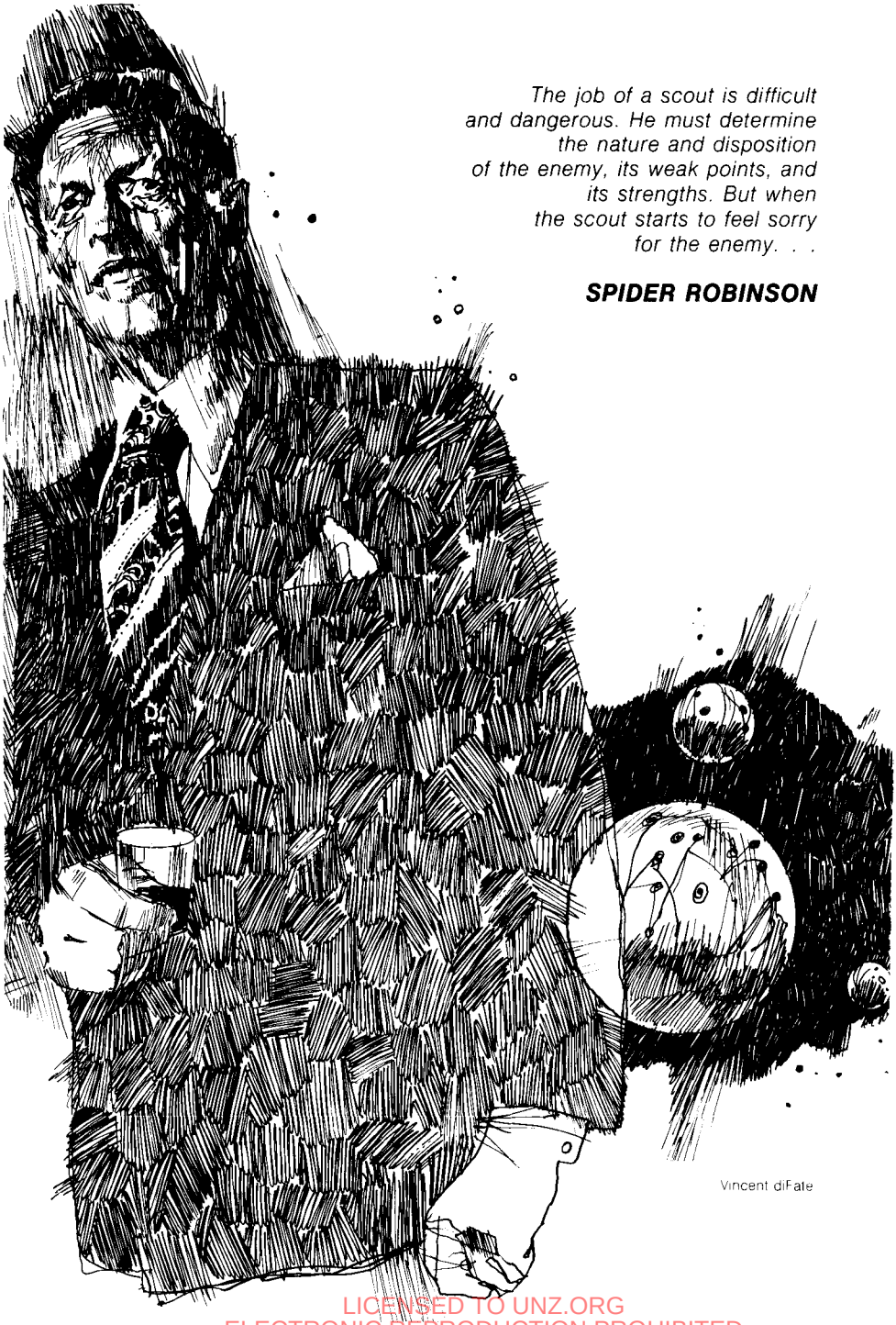

The job of a scout is difficult and dangerous. He must determine the nature and disposition of the enemy, its weak points, and its strengths. But when the scout starts to feel sorry for the enemy. . .

SPIDER ROBINSON

Vincent diFate

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Callahan's Place was pretty lively that night. Talk fought Budweiser for mouth space all over the joint, and the beer-nuts supply was critical. But this guy managed to keep himself in a corner without being noticed for nearly an hour. I only spotted him myself a few minutes before all the action started, and I make a point of studying *everybody* at Callahan's Place.

First thing, I saw those eyes. You get used to some haunted eyes in Callahan's—the newcomers have 'em, but these reminded me of a guy I knew once in Topeka, who got four people with an antique revolver before they cut him down.

I hoped like hell he'd visit the fireplace before he left.

If you've never been to Callahan's Place, God's pity on you. Seek it in the wilds of Suffolk County, but look not for neon. A simple, hand-lettered sign illuminated by a single floodlight, and a heavy oaken door split in the center (by the head of one Big Beef Mac affray circa 1947) and poorly repaired.

Inside, several heresies.

First, the light is about as bright as you keep in your living room. Callahan maintains that people who like to drink in caves are unstable.

Second, there's a flat rate. Every drink in the house is half a buck, with the option. The option operates as follows:

You place a one-dollar bill on the bar. If all you have on you is a fin, you trot across the street to the all-night deli, get change, come back and put a one-dollar bill on the bar. (Callahan points out that nobody in his right mind would counterfeit one-dollar bills; most of us figure he just likes to rub fistfuls of them across his face after closing.)

You are served your poison-of-choice. You inhale this, and confront the option. You may, as you leave, pick up two quarters from the always-full cigar box at the end of the bar and exit into the night. Or you may, upon finishing your drink, stride up to the chalk line in the middle of the room, announce a toast (this is mandatory) and hurl your glass into the huge, old-fashioned fireplace which manages to take up most of the back wall. You then depart without visiting the cigar box. Or, pony up another buck and exercise your option again.

Callahan seldom has to replenish the cigar box. He orders glasses in such immense quantities that they cost him next to nothing, and he sweeps out the fireplace himself every morning.

Another heresy: no one watches you with accusing eyes to make sure you take no more quarters than you have coming to you. If Callahan ever happens to catch someone cheating him, he personally ejects him forever. Sometimes he doesn't open the door first. The

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last time he had to eject someone was in 1947, a gentleman named Big Beef McCaffrey.

Not too surprisingly, it's a damned interesting place to be. It's the kind of place you hear about only if you need to—and if you are very lucky. Because if a patron, having proposed his toast and smithereened his glass, feels like talking about the nature of his troubles, he receives the instant, undivided attention of everyone in the room. (That's why the toast is obligatory. Many a man with a hurt locked inside finds in the very act of naming his hurt for the toast that he wants very much to talk about it. Callahan is one smart hombre.) On the other hand, even the most tantalizingly cryptic toast will bring no prying inquiries if the guy displays no desire to uncork. Anyone attempting to flout this custom is promptly blackjacked by Fast Eddie the piano-player and dumped in the alley.

But somehow many do feel like spilling it in a place like Callahan's; and you can get a deeper insight into human nature in a week there than in ten years anywhere else I know. You can also quite likely find solace for most any kind of trouble, from Callahan himself if no one else. It's a rare hurt that can stand under the advice, help and sympathy generated by upwards of thirty people that *care*. Callahan loses a lot of his regulars. After they've been around often enough, they find they don't need to drink anymore.

It's that kind of a bar.

I don't want you to get a picture of Callahan's Place as an agonized, Alcoholics-Anonymous-type group-encounter session, with Callahan as some sort of salty psychoanalyst-father-figure in the foreground. Hell, many's the toast provokes roars of laughter, or a shouted chorus of agreement, or a unanimous blitz of glasses from all over the room when the night is particularly spirited. Callahan is tolerant of rannygazoo; he maintains that a bar should be "merry," so long as no bones are broken unintentionally. I mind the time he helped Spud Flynn set fire to a seat cushion to settle a bet on which way the draft was coming. Callahan exudes, at all times, a kind of monolithic calm; and U.S. 40 is shorter than his temper.

This night I'm telling you about, for instance, was nothing if not merry. When I pulled in around ten o'clock, there was an unholy shambles of a square dance going on in the middle of the floor. I laid a dollar on the bar, collected a glass of Tullamore Dew and a hello-grin from Callahan, and settled back in a tall chair—Callahan abhors barstools—to observe the goings-on. That's what I mean about Callahan's Place: most bars, men only dance if there're ladies around.

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I picked some familiar faces out of the maelstrom of madmen weaving and lurching over honest-to-God sawdust, and waved a few greetings. There was Tom Flannery, who at that time had eight months to live, and knew it; he laughed a lot at Callahan's Place. There was Slippery Joe Maser, who had two wives, and Marty Matthias, who didn't gamble anymore, and Noah Gonzalez, who worked on Suffolk County's Bomb Squad. Calling for the square dance while performing a creditable Irish jig was Doc Webster, fat and jovial as the day he pumped the aspirins out of my stomach and ordered me to Callahan's. See, I used to have a wife and daughter before I decided to install my own brakes. I saved three dollars, easy.

Doc left the square-dancers to their fate—their creative individuality making a caller superfluous—and drifted over like a pink zeppelin to say hello. His stethoscope hung unnoticed from his ears, framing a smile like a sunlamp. The end of it was in his drink.

"Howdy, Doc. Always wondered how you kept that damned thing so cold," I greeted him.

He blinked like an owl with the shingles and looked down at the glass's bubbling pickup beneath two fingers of Scotch. Emitting a rich roar of laughter at about force 6, he removed the gleaming tube and shook it experimentally.

"My secret's out, Gus. Keep it under your hat, will you?" he rumbled.

"Maybe you better keep it under yours," I suggested. He appeared to consider this idea for a time, while I speculated on one of life's great paradoxes: Sam Webster, M.D. Doc is good for a couple or three quarts of Peter Dawson a night, three or four nights a week. But you won't find a better sawbones anywhere on Earth, and those sausage fingers of his can move like a tap-dancing centipede when they have to, with nary a tremor. Ask Shorty Steinitz to tell you about the time Doc Webster took out his appendix on Callahan's bar—while Callahan calmly kept the Scotch coming.

"At least then I could hear myself think," Doc finally replied, and several people seated within earshot groaned theatrically.

"Have a heart, Doc," one called out.

"What a re-pulse-ive idea," Doc returned the serve.

"Well, I know when I'm beat," said the challenger, and made as if to turn away.

"Why you young whelp, aorta poke you one," roared Doc, and the bar exploded with laughter and cheers. Callahan picked up a beer bottle in his huge hand and pegged it across the bar at Doc's round skull. The beer bottle, being made of foam rubber, bounced gracefully into the air and landed in the piano, where Fast Eddie Costigan sat

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locked in mortal combat with "C-Jam Blues."

Fast Eddie emitted a sound like an outraged transmission and kept right on playing, though his upper register was shot. "Little beer never hurt a piano," he sang out as he reached the bridge, and went over it like he figured to burn it behind him.

All in all, it looked like a cheerful night, but then I saw the Janssen kid come in and I knew there was a trouble brewing.

This Janssen kid—look, I can't knock long hair, I wore mine long when it wasn't fashionable. And I can't knock pot for the same reason. But nobody I know ever had a good thing to say for heroin. Certainly not Joe Hennessy, who did two weeks in the hospital last year after he surprised the Janssen kid scooping junk-money out of his safe at four in the morning. Old Man Janssen paid Hennessy back every dime and disowned the kid, and he'd been in and out of sight since. Word was he was still using the stuff, but the cops never seemed to catch him with anything. They sure did try, though. I wondered what in hell he was doing in Callahan's Place.

I should know better by now. He placed a tattered bill on the bar, took the shot of bourbon which Callahan handed him silently, and walked to the chalk line. He was quivering with repressed tension, and his boots squeaked on the sawdust. The place quieted down some, and his toast—"To skag!"—rang out clear and crisp. Then he downed the shot amid an expanding silence and flung his glass so hard you could hear his shoulder crack just before the glass shattered on unyielding brick.

Having made silence, he broke it. With a sob. Even as he let it out he glared around to see what our reactions were.

Callahan's was immediate, an "Amen!" that sounded like an echo of the smashing glass. The kid made a face like he was somehow satisfied in spite of himself, and looked at the rest of us. His gaze rested on Doc Webster, and the doc drifted over and gently began rolling up the kid's sleeves. The boy made no effort to help or hinder him. When they were both rolled to the shoulder—phosphorescent purple I think they were—he silently held out his arms.

They were absolutely unmarked. Skinny as hell and white as a piece of paper, but unmarked. The kid was clean.

Everyone waited in silence, giving the kid their respectful attention. It was a new feeling to him, and he didn't quite know how to handle it. Finally he said, "I heard about this place," just a little truculently.

"Then you must of needed to," Callahan told him quietly, and the kid nodded slowly.

"I hear you get some answers in,

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from time to time," he half-asked.

"Now and again," Callahan admitted. "Some of the damnedest questions, too. What's it like, for instance?"

"You mean skag?"

"I don't mean bourbon."

The kid's eyes got a funny, faraway look, and he almost smiled. "It's . . ." He paused, considering. "It's like . . . being dead."

"Whooee!" came a voice from across the room. "That's a powerful good feeling indeed." I looked and saw it was Chuck Samms talking, and watched to see how the kid would take it.

He thought Chuck was being sarcastic and snapped back. "Well, what the hell do you know about it anyway?" Chuck smiled—a lot of people ask him that question, in a different tone of voice.

"Me?" he said, enjoying himself hugely. "Why I've been dead is all!"

"S'truth," Callahan confirmed as the kid's jaw dropped. "Chuck here was legally dead for five minutes before Doc got his pacemaker goin' again."

"Sure was nice, too," Chuck said around a yawn. "More peaceful than nap-time in a monastery. If it wasn't so pleasant I wouldn't be near so damned scared of it." There was an edge to his voice as he finished, but it disappeared as he added softly, "What the hell would you want to be dead for?"

The Janssen kid couldn't meet his eyes, and when he spoke his voice cracked. "Like you said, Pop, peace. A little peace of mind, a little quiet. Nobody yammering at you all the time. I mean if you're dead there's always the chance someone'll mourn, right? Make friends with the worms, dig *their* side of it, maybe a little poltergeist action, who knows? I mean, what's the sense of talking about it, anyway? Didn't any of you guys ever just want to run away?"

"Sure thing," said Callahan. "Sometimes I do it too. But I generally run someplace I can find my way back from." It was said so gently that the kid couldn't take offense, though he tried.

"Run away from what, son?" asked Slippery Joe.

The kid had been bottled up tight too long; he exploded. "From what?" he yelled. "Jesus, where do I start? There's this war they want me to go fight, see? And there's this place called college, I mean they want you to care, dig it, *care* about this education grail, and they don't care enough themselves to make it as interesting as the crap game down the street. There's this air I hear is unfit to breathe, and water that ain't fit to drink, and food that wouldn't nourish a vulture and a nice little future all picked out for you, Jackson, just pick out your pigeonhole and start rotting. It's O.K. to kill as long as they're the bad guys and it's O.K. to make love as long as they're the

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bad girls and you ask me what in the name of God I'm running from?

"Man, I've been straight for seven months, what I mean, and in that seven God-damned months I have been over this town like a fungus and there is *nothing* for me. No job, no friends, noplace to live long enough to get the floor dirty, no money and nobody that doesn't point and say, 'Junkie' when I go by for seven *months* and you ask me what am I running from? Man, *everything* is all, just everything."

It was right then that I noticed that guy in the corner, the one with the eyes. Remember him? He was leaning forward in rapt attention, mouth a black slash in a face pulled tight as a drumhead. Those ghastly eyes of his never left the Janssen kid, but somehow I felt that his awareness included all of us, everyone in the room.

And no one had an answer for the boy. I could see, all around the room, men who had learned to *listen* at Callahan's Place, men who had learned to empathize, to want to understand and share the pain of another. And no one had a word to say. They were thinking past the blurted words of a haunted boy, wondering if this crazy world of confusion might not after all be one holy hell of a place to grow up. Most of them already had reason to know damned well that society *never* forgives the sinner, but they were realizing to their dismay how thin and uncomforting the straight and narrow has become.

Oh, sure, they'd heard these things before. I'd given them a few monologues myself, and they'd told me I spoke in clichés. But now I could see them reflecting that these were the clichés that made a young man say he liked to feel dead, and the same thought was mirrored on the face of each of them: *My God, when did we let these things become clichés*? The Problem of Today's Youth was no longer a Sunday supplement or a news broadcast or anything so remote and intangible, it was a dirty, shivering boy who told us that in this world we had built for him with our sweat and our blood he was not only tired of living, but so *un*scared of dying that he did it daily, sometimes, for recreation.

And silence held court in Callahan's Place. No one had a single thing to say, and that guy with the eyes seemed to know it, and to derive some crazy kind of bitter inner satisfaction from the knowledge. He started to settle back in his chair, when Callahan broke the silence.

"So run," he said.

Just like that, flat, no expression, just, "So run." It hung there for about ten seconds, while he and the kid locked eyes.

The kid's forehead started to bead with sweat. Slowly, with shak-

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ing fingers, he reached under his leather vest to his shirt pocket. Knuckles white, he hauled out a flat shiny black case about four inches by two. His eyes never left Callahan's as he opened it and held it up so that we could all see the gleaming hypodermic. It didn't look like it'd ever been used; he must have just stolen it.

He held it up to the light for a moment, looking up his bare, unmarked arm at it, and then he whirled and flung it, case and all, into the giant fireplace. Almost as it shattered he sent a cellophane bag of white powder after it, and the powder burned green while the sudden silence hung in the air. The guy with the eyes looked oddly stricken in some interior way, and he sat absolutely rigid in his seat.

And Callahan was around the bar in an instant, handing the Janssen kid a beer that grew out of his fist and roaring, "Welcome home, Tommy!" and no one in the place was very startled to realize that only Callahan of all of us knew the kid's first name.

We all sort of swarmed around then and swatted the kid on the arm some and he even cried a little until we poured some beer over his head and pretty soon it began to look like the night was going to get merry after all.

And that's when the guy with the eyes stood up, and everybody in the joint shut up and turned to look at him. That sounds melodramatic, but it's the effect he had on us. When he moved, he was the center of attention. He was tall, unreasonably tall, near seven foot, and I'll never know why we hadn't all noticed him right off. He was dressed in a black suit that fit worse than a Joliet Special, and his shoes didn't look right somehow. After a moment you realized that he had the left shoe on the right foot, and vice versa, and somehow it didn't surprise you. He was thin and deeply tanned and his mouth was twisted up tight but mostly he was eyes, and I still dream of those eyes and wake up sweating now and again. They were like windows into hell, the very personal and private hell of a man faced with a dilemma he cannot resolve. They did not blink, not once.

He shambled to the bar, and something was wrong with his walk, too, like he was walking sideways on the wall with magnetic shoes and hadn't quite caught the knack yet. He took ten new singles out of his jacket pocket—which struck me as an odd place to keep cash—and laid them on the bar.

Callahan seemed to come back from a far place, and hustled around behind the bar again. He looked the stranger up and down and then placed ten shot glasses on the counter. He filled each with rye and stood back silently, running a big red hand through his thinning hair and regarding the stranger with a clinical interest.

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The dark giant tossed off the first shot, shuffled to the chalk line, and said in oddly accented English, "To my profession," and hurled the glass into the fireplace.

Then he walked back to the bar and repeated the entire procedure. Ten times.

By the last glass, brick was chipping in the fireplace.

When the last, "To my profession," echoed in empty air, he turned and faced us. He waited, tensely, for question or challenge. There was none. He half turned away, paused, then swung back and took a couple of deep breaths. When he spoke his voice made you hurt to hear it.

"My profession, gentlemen," he said, with that funny accent none of us could place, "is that of an advance scout. For a race whose home is many light-years from here. Many, many light-years from here." He paused, looking for our reactions.

Well, I thought, *ten whiskeys and he's a Martian. Indeed. Pleased to meet you, I'm Popeye the Sailor.* I guess it was pretty obvious we were all thinking the same way, because he looked tired and said, "It would take far more ethanol than that to befuddle me, gentlemen." Nobody said a word to that, and he turned toward Callahan. "You know I am not intoxicated," he stated.

Callahan considered him professionally and said finally, "Nope. You're not tight. I'll be a son of a bitch, but you're not tight."

The stranger nodded thanks, spoke thereafter directly to Callahan. "I am here now since three days. In two hours I will be finished. When I am finished I shall go home. When I have gone your planet will be vaporized. I have accumulated data which will ensure the annihilation of your species when they are assimilated by my Masters. To them, you will seem as cancerous cells, in danger of infecting all you touch. You will not be permitted to exist. You will be *cured.* And I repent me of my profession."

Maybe I wouldn't have believed it anywhere else. But at Callahan's Place *anything* can happen. Hell, we all believed him. Fast Eddie sang out, "Anything we can do about it?" and he was serious for sure. You can tell with Fast Eddie.

"I am helpless," the giant alien said dispassionately. "I contain . . . installations . . . which are beyond my influencing—or yours. They have recorded all the data I have perceived in these three days; in two hours they will be triggered by a preset mechanism and will transmit their contents to the Masters." I looked at my watch: it was eleven-fifteen. "The conclusions of the Masters are foregone. I cannot prevent the transmission; I cannot even attempt to. I am counter-programmed."

"Why are you in this line of

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work if it bugs you so much?" Callahan wanted to know. No hostility, no panic—he was trying to *understand.*

"I am accustomed to take pride in my work," the alien said. "I make safe the paths of the Masters. They must not be threatened by aggressive species. I go before, identify danger, and see to its neutralization. It is a good profession, I think. I thought."

"What changed your mind?" asked Doc Webster sympathetically.

"This place, this . . . 'bar' place we are in. This is not like the rest I have seen. Outside are hatred, competition, morals elevated to the status of ethics, prejudices elevated to the status of morals, whims elevated to the status of prejudices, all things with which I am wearily familiar, the classic symptoms of dissolution.

"But here is difference. Here in this place I sense qualities, attributes I did not know your species possessed, attributes which everywhere else in the known universe are mutually exclusive of all else that I have seen. Like the vacuum are the things I have perceived here tonight. They . . . these things . . . they make me . . . anguish for your passing. . . . me with hurt . . . that I might lay down my . . . cried. "I did not know . . . you had love!"

In the echoing stillness, Callahan . . . simply. "Sure we do, son. It's mebbe spread a little thin these days, but we got it all right. Sure would be a shame if it all went up in smoke." He looked down at the rye bottle he still held in his big right hand, and absently drank off a couple ounces. "Any chance that your Masters might feel the same way?"

"None. Even I can still see that you must be destroyed if the Masters are to be safe. But for the first time in thousands of your years, I regret my profession. I fear I can do no more."

"No way you can gum up the works?"

"No. I could not assemble the volition. I have said: I am counter-programmed."

I saw Noah Gonzalez' expression soften, heard him say, "Geez, buddy, that's hard lines." A mumbled agreement rose, and Callahan nodded slowly.

"That's tough, brother. I wouldn't want to be in your shoes."

He looked at us with absolute astonishment, the hurt in those terrible eyes of his mixed now with bewilderment. Shorty handed him another drink and it was like he didn't know what to do with it.

"You tell us how much it will take, mister," Shorty said respectfully, "and we'll get you drunk."

The tall man with star-burned skin groaned from deep inside himself and backed away until the fireplace contained him. He and the

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flames ignored each other, and no one found it surprising.

"What is your matter?" he cried. "Why are you not destroying me? You fools, you need only destroy me and you are saved. I am your judge. I am your jury. I will be your executioner."

"You didn't ask for the job," Shorty said gently. "It ain't your doing."

"But you do not understand! If my data are not transmitted, the Masters will assume my destruction and avoid this system forever. Only the equal or superior of a Master could overcome my defenses, but I *can* control *them.* I will not use them. Do you comprehend me? I will not activate my defenses—you can destroy me and save yourselves and your species, and I will not hinder you.

"Kill me!" he shrieked.

There was a long, long pause, maybe a second or two, and then Callahan pointed to the drink Shorty still held out and growled, "You better drink that, friend. You need it. Talkin' of killin' in my joint. Wash your mouth out with bourbon and get outta that fireplace, I want to use it."

"Yeah, me too!" came the cry on all sides, and the big guy looked like he was gonna cry. Conversations started up again and Fast Eddie began playing "I Don't Want to Set the World on Fire," in very bad taste indeed.

Some of the boys wandered thoughtfully out, going home to tell their families, or settle their affairs. The rest of us, lacking either concern, drifted over to console the alien. I mean, where else would I want to be on Judgment Day?

He was sitting down, now, with poisons of all kinds on the table before him. He looked up at us like a wounded giant. But none of us knew how to begin, and Callahan spoke first.

"You never did tell us your name, friend."

The alien looked startled, and he sat absolutely still, rigid as a fence post, for a long, long moment. His face twisted up awful, as though he was waging some titanic inner battle with himself, and cords of muscle stood up on his neck in what didn't seem to be the right places. Doc Webster began to talk to himself softly.

Then the alien went all blue and shivered like a steel cable under strain, and very suddenly relaxed all over with an audible gasp. He twitched his shoulders experimentally a few times, like he was making sure they were still there, and then he turned to Callahan and said, clear as a bell, "My name is Michael Finn."

It hung in the air for a very long time, while we all stood petrified, suspended.

Then Callahan's face split in a wide grin, and he bellowed, "Why of course! Why yes, yes of course,

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Mr. Michael Finn. I didn't recognize you for a moment, Mr. Finn," as he trotted behind the bar. His big hands worked busily beneath the counter, and as he emerged with a tall glass of dark fluid the last of us got it. We made way eagerly as Callahan set the glass down before the alien, and stood back with the utmost deference and respect.

He regarded us for a moment, and to see his eyes now was to feel warm and proud. For all the despair and guilt and anguish and horror and most of all the hopelessness were gone from them now, and they were just eyes. Just like yours and mine.

Then he raised his glass and waited, and we all drank with him. Before the last glass was empty his head hit the table like an anvil, and we had to pick him up and carry him to the back room where Callahan keeps a cot, and you know, he was *heavy*.

And he snored in three stages. ■

in times to come

Twenty years ago, in our March 1953 issue, we featured a story called "Thou Good and Faithful," by a new British writer, John Brunner. In next month's issue, as a sort of anniversary celebration, Brunner has produced "Who Steals My Purse." It's a realistic treatment of how to win a war very much like the Vietnam conflict. The cover is by John Schoenherr.

The basic problem of the so-called brushfire wars is the total mismatch between a major technologically sophisticated nation's ability to wage war, and its aims in going into such a war. No one doubts, for example, that the United States could destroy most of the world, let alone a small backward Asian nation. Yet we hold our vast technological superiority in abeyance, for political reasons. Brunner shows, beautifully, how to use our technology to achieve our objectives, despite the protests of a large segment of the American people against the war.

Part two of Poul Anderson's "People of the Wind" will also grace our March issue, along with as many short stories as we can fit in. The fact article is "The Eyes Have It," by R. I. MacDonald.

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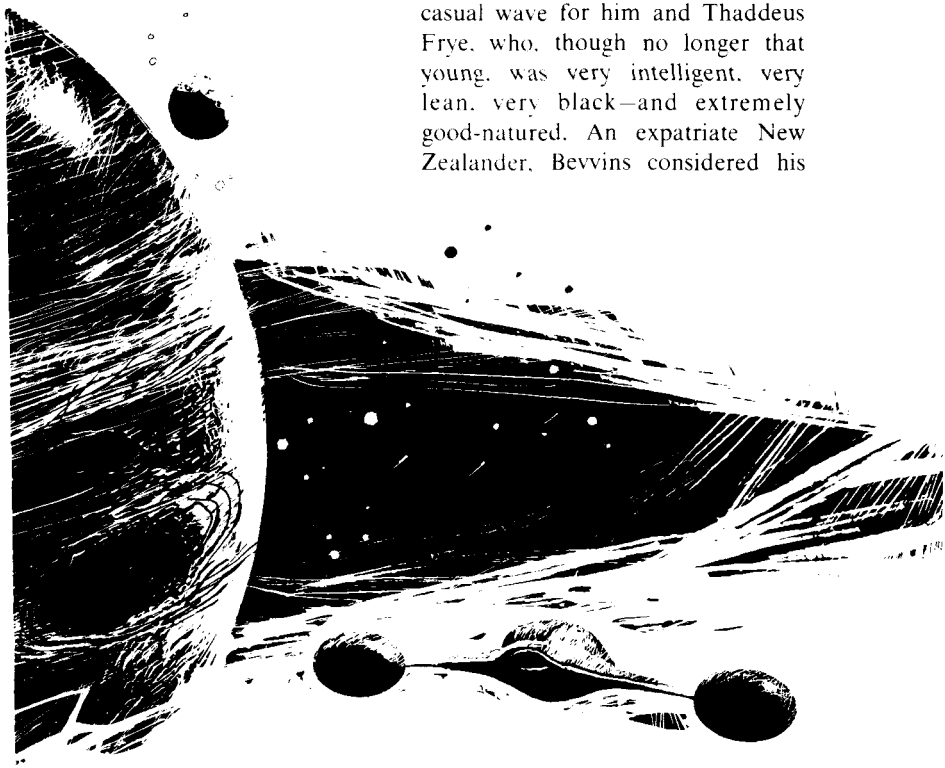
MODUS VIVENDI

The most critical step in any medical experiment is going from test animals to human trials. Usually this step is taken very carefully. But sometimes . . .

WILLIAM WALLING

"Greetings, respected colleagues!"

Clancy Bevvins looked up as Lee Gresham, still youthful enough to be flippant about his troubles, swam through the research satellite's commissary hatchway with a casual wave for him and Thaddeus Frye, who, though no longer that young, was very intelligent, very lean, very black—and extremely good-natured. An expatriate New Zealander, Bevvins considered his



VINCENT diFATE

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own troubles to be all in the past. He was returning to Earth in exactly forty-one days. He was counting the days.

"Hullo, Lee," hailed Bevvins. "Off watch so soon?"

"Uh-huh!" Gresham closed the hatch, which battened automatically behind him. He floated to the hand rail, tugged himself into what passed for a sitting position at the bench, and wearily clipped a folder bursting with photo plates and notes in the hold-down fixture on the table.

"Why, good evening, Dr. Gresham," said Frye with a twinkle. "How are things out in your lonesome observatory?"

Gresham rubbed his eyes. He dialed for coffee before answering. "Today, I spent six hours staring into that damned blink comparator," he said. "Ever tell you I'm thinking of writing a book? I'll call it *The Vicissitudes of an Astrophysicist.*"

Bevvins and Frye exchanged amused glances. "I say! That's some sensational sizzler of a title," hissed Bevvins. "But, you've never gotten round to explaining whatever it is you're searching for."

Gresham's lip curled. "That again? You two never tire of baiting the new help, do you? You know I can't talk about it."

"More secret government jazz, eh, Lee?" asked Thad Frye dryly.

Gresham sucked his squeeze bottle of coffee, leering at them from pale, bloodshot eyes. He swallowed, lifting the tube from his lips. "It won't work; no more put-ons, thank you kindly," he said. "By the way, Dr. Bevvins, what's a nice cellular physiologist like you doing in a place like this?"

Frye's hearty laugh boomed through the small compartment. "When in doubt, attack! You're learning, my boy."

Bevvins chuckled. "Actually, there's nothing secret about my work," he said, hoping that it sounded convincing. The sally had merely been young Gresham's way of congratulating him upon his imminent return home—his "escape," as the astronomer insisted on putting it. "I've been tracking something rather interesting, you see. Did a good bit of the early work sunward, in Phobos Station, then decided to move out away from primary solar radiation as far as was practicable—"

"—And solved the riddle of life," suggested Gresham tiredly, "with old Jupiter's help."

"No, not really. Jupiter's a distraction, if anything. Getting stuck here in Zipper One was the commissioner's idea, not mine. It was the only facility this far out with lab space available for me, Hector, Bess, and the others."

"Oh, your chimps."

"Uh, gibbons," corrected Bevvins. "I've no complaints whatsoever. Don't mistake me, I shall certainly be glad to see Christ-

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church again. But, it's been quite rewarding."

"Wouldn't Ganymede Base have done as well?" asked Gresham. "It's a lot more comfortable than this tin bar-bell; room to move around, and at least a *little* weight on your feet."

Bevvins shook his head. "I'm afraid weightlessness is a requisite, Lee. That is, my studies demand . . . no need to bore you with a lot of medical frou-frou." He patted the tabletop. "Zipper's been good to me. I've accomplished more than I'd dreamed possible in my six months with you chaps."

Heavily shielded against the strongest Van Allen radiation belt in the entire solar system, Zipper One, technically Jupiter Research Satellite One, hurtled around the largest of the planets in a high velocity orbit just inside the groove of the tiny moon Amalthea, which circled but seventy thousand nautical miles from the banded giant. Trapped in a cross-rough of physical science specialties making up the other nine members of Zipper's research crew, Dr. Bevvins had agreed to "pay his way" by doubling as the station's medical officer. He had resented the time stolen from his own work in relieving sprains, checking urine samples, and filling pills.

Finishing his coffee, Lee Gresham took out a black-bowled briar from the flash pocket of his jumpsuit. He chewed the dry stem fitfully, a faraway look in his pale blue eyes.

Thad Frye winked at Bevvins. "The old nicotine heeby-jeebies hassling you again, Lee? I thought you'd kicked the habit."

Gresham made a disgruntled sound. "Just one more vicissitude we astrophysicists must face," he said theatrically, stressing the sibilants. "I miss my damned pipe more and more every minute. One of these days, I'm going to stoke it and light up—and to hell with regulations!"

Frye clucked in mock disapproval. "In a pure oxygen environment? Naughty, naughty!" He stretched and groped for the overhead hand rail. "Well, I expect it's time to go and relieve Kawashima on watch, gentlemen. Better keep an eye on our junior colleague, Clancy. Those vicissitudes may gang up on him and get completely out of hand."

His broad, negroid features crinkled pleasantly, the gangling older man made one long-armed heave on the freefall line as Gresham sheepishly stuffed his pipe back in his pocket. Smiling, Bevvins simply nodded his good-bye.

Dr. Thaddeus Frye, whose specialty was cryogenic physics, was just reaching out to pop open the hatch, when the sound hit them—a high-pitched grinding noise, followed almost immediately by the squalling howl of the pressure warning klaxon.

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Bevvins, his heart in his throat, lifted his feet to shove away from the table. Mild acceleration nearly sent him flying. He grabbed for the bench, and saw Thad Frye tumble past end-over-end to crash against the galley bulkhead and slide limply back toward the deck.

Gresham clung to the table opposite Bevvins, yelling, "We've been hulled!" He shouted it, inanely, over and over again.

Slowly, the acceleration dwindled. They were weightless once more. Bevvins found himself trembling. He stared blankly at Gresham for an instant before he pushed free of the bench. "Come, let's see to Thad."

Frye groaned and stirred as Dr. Bevvins clasped his wrist. He peeled up one of the physicist's eyelids, while Gresham hovered anxiously close by. At last, Frye opened the other eye, gingerly rubbing his temple. "Some ride, that was! What happened?"

"We've no idea, just yet," Bevvins said. "You look to be all right. How do you feel?"

Dr. Frye fingered his thinning, kinky hair. "Short of a knob on the skull, and a sore shoulder, I guess I'm in one piece, but . . ." He paused, his nostrils flaring. "Clancy, if what I hear—or *don't* hear—isn't my imagination, we're in a peck of trouble."

"What is it?" asked Bevvins.

"The blowers are off," said Frye. "At least, *I* don't hear them. Our life support system must be out. Listen!"

The warning klaxon had stopped howling. Bevvins and Gresham strained with every sense into the stillness.

Zipper One's commissary compartment was quiet as the tomb it might very soon become.

Gresham punched one intercom switchlight after another. "Hello, A deck; anybody in A deck?" He repeated the call for B, C, and D decks, then tried to reach the service compartment two levels beneath them, as well as the power reactor module which occupied the far section of the dumbbell-shaped structure Zipper One resembled. The response from every intercom station was the same—chilling silence.

"No one's out in the observatory," said Gresham, frowning. "I know; I just came in from there." There was a good deal of fright in his expression.

"Clancy, how much air's in here?" asked Frye, clenching and unclenching his fists.

"Uh, something like three or four hours of usable air, I'd guess," said Bevvins. "But we've got to find out what the situation is straight off. Have we a survival kit?"

"There's one in every compartment," said Frye, "but . . ."

"I know what you're thinking, Thad." Bevvins was grim. "You are

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speculating upon whether there is still air beyond the hatch."

Gresham looked from one to the other. He pulled out his pipe for comfort, his brow wrinkled. "Hard to say, but we'll have to keep hoping. We might be able to save the others if we move fast. Everyone agree?"

Frye clapped his hands. "Done!" He shoved away to get the emergency kit. A huge, red dayglo arrow pointed to the survival locker in the pantry, just off the galley. The emergency p-suit Frye broke out was fashioned of light-weight, sealant-impregnated mesh, topped with an ovoid fishbowl. The chest-slung oxygen bottle would sustain a man in vacuum for only about twenty minutes.

"We'll draw straws," suggested Gresham.

"Put away your pipe, Lee," ordered Bevvins. "We shall have to count on you; you're the youngest and strongest. We'll assume the remainder of C deck is intact."

"Come on, Lee," urged Frye, "snap it up!"

With expertise gained in long practice, Gresham wriggled into the p-suit in mid-air, while Frye hung behind him and checked out the flow valve. Before clamping down the fishbowl, Gresham said, "First, I'll look through living quarters, then work my way up to A deck and get a mayday tape ready to put on the lasercomm transmitter." He squinted at the wall chronometer which read in universal time. "Ganymede should be nearing opposition; it will be several hours before we can fire off a signal, but it's best to be ready. Sound O.K.?"

"Find out as much as you can," said Bevvins. "Check on my animals, too, if you get near the lab."

"Will do." Gresham hurriedly sealed up. He flew to the hatch.

Thad Frye made a thumb and forefinger doughnut of encouragement, muttering, "Go on, son; don't keep us in suspense."

The two older men held their breath, knowing the hatch would refuse to open if the passageway beyond held no air, dooming them to hours of slow suffocation. Bevvins wasn't at all sure he could stand that.

Lee Gresham stabbed the button. The hatch opened normally. He disappeared, and the hatch battened behind him.

"Whew! I'm getting too old and paunchy for this sort of drill," said Bevvins. "Did it sound like a puncture, do you think? Pressure loss doesn't scare me half so much as that acceleration. What the devil could have caused it, Thad?"

Frye refused to guess. "Lee will find out. What say we have a look outside? It may give us a clue." He tugged open the dogs securing the radiation-proof cover of a two-foot diameter peek-a-boo, and swung the cover back against the bulkhead.

Zipper One was tumbling very,

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very slowly in a clockwise direction. The looming, crescent bulge of Jupiter shouldered up to fill the glass, a kaleidoscope of turbulated belts ranging from bluish-white to pastel yellow, and down the color scale to rich saffron and ochre. The red spot broke the south tropical current flow like a glowing, reddish-gray wound, bounded by a vortex swirl of frozen atmospheric ammonia crystals.

Most bodies, when seen from space, appeared suspended as in a diorama—"out" rather than "down." To Bevvins and Frye, there was no doubt at all; they were looking *down* into a gravity well more than two and one half times deeper than that of Earth. Near the darkened limb, a single bright dot swam against blackness—probably Io—while the shadow of Callisto crawled in transit near the terminator. Thousands of miles below the shadow, gravity had crushed Jupiter's core into a solid mass of compacted hydrogen atoms.

"Zipper's picked up some angular momentum," mused Dr. Frye, rubbing his jaw. "Attitude computer must be out, too, or we'd have corrected by now. Doesn't look promising, does it, Clancy?"

Bevvins mumbled something appropriately incoherent. He found himself thinking of the sheep station in Mackenzie Basin where he had lived as a boy: lacy white clouds scudding in an azure sky, with Mount Cook and the Southern Alps serrating the horizon. But New Zealand lay forty-seven light-minutes sunward. Bevvins had a sudden, sharp premonition that he would never see South Island again.

They waited, nerves jangling—though both tried hard not to show it—until the opening hatch grated behind them. Lee Gresham unsnapped the dogs of his fishbowl. He tilted it back, his features jelled in dismay; above high cheekbones, his eyes were hollow.

"Bad?" asked Frye bluntly.

Gresham's nod was profound. "Bad! A good-sized chunk of debris took us dead-on—probably a piece of sky-junk from the Trojans. Four were asleep in their bunks when B deck depressurized. They aren't . . . pretty to look at.

"Kawashima and Bispham were stowing electronics spares in the service compartment. They didn't have a chance. Burke was up in A deck. He did manage to break out a suit—almost got into it—but . . ."

"Ruddy awful!" Bevvins folded his arms, blinking back tears. "Then, we're all . . . that's left. How about the oxygen reservoirs?"

"It couldn't have been worse," said Gresham dully. "Draw a line through the main pressure vessel down in service, up through all decks to the backup supply in A deck, and you'll have the projectile's path. It took the lower tank squarely, rupturing both hemi-

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spheres, then struck the upper reservoir tangentially and ripped a foot-long gash. The erupting lox was what gave us that acceleration nudge, as well as some spin."

"Good Lord!"

Thad Frye had listened closely. "Perhaps it did something else, too," he said. "If I've followed your description, that gash in the A deck tank opens on the spaceward side, away from Jupiter."

"I know." Gresham was perspiring. "I would have to run some numbers through the machine to be certain, but it looks like the thrust may have disturbed our orbit. Zipper might eventually decay and go in, if the guidance computer and thrusters are out.

But that's not our main worry. There doesn't seem to be enough oxygen left aboard to keep *one* man alive till we're relieved, let alone three!"

Gresham went back up to A deck to critically align the laser-comm transmitter and set the timer. Even considering their combined orbital vectors, Ganymede would not rise into Zipper's line-of-sight for another two-plus hours. When the huge moon did appear, not only the radiation belt in which Zipper orbited would act to make ordinary radio communication totally useless, like an unlighted neutron star, mighty Jupiter emitted much more energy than it received from the distant sun, including a chaotic jumble of radio frequencies that blanketed all wavebands with crackling intensity. Only modulated light communication was possible between Zipper One and Jupiter's natural satellite.

While Gresham was gone, Bevvins and Frye took inventory. Three quadrants of C deck, including the commissary, had been reported intact by Gresham, although there was no practical way to scavenge the remaining free air and bottle it. Zipper One, equipped for a personnel complement of ten, was just below the efficiency break-even point necessary to carry oxygen regeneration equipment on board. Liquid Oxygen, stored in primary and backup pressure vessels installed poles apart in the crew module to lessen the chance of *both* being ruptured by a single meteoroid, was replenished periodically by logistic resupply shuttles from Ganymede. Unfortunately, the large EVA bottles needed for spaceside activity were charged from reduction tanks plumbed to the main storage vessels, rather than being held permanently charged in the air lock service area.

"Hell's fire! This deck of cards is *really* stacked against us!" Thad Frye looked very glum. "There might be a partial charge in a scattered bottle or two, but . . . Clancy, you all right?"

"Eh? Yes, of course, Thad. I was thinking of something else. Never mind; it's too ridiculous to . . .

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You are perfectly correct; it requires nearly two mass-pounds of oxygen per man, per day, to stay alive.

"Barring the air remaining in C deck, and perhaps several compartments in other decks, what we have left could be measured in ounces."

Thad Frye's lips pursed in a silent whistle. "That's it, then. Even if there *were* only one of us . . . I don't see a way home, Clancy. Do you?"

But Dr. Bevvins had taken to staring absently down at Jupiter. He seemed to have withdrawn within himself, deep in thought. Frye respected his privacy, but watched him with an anxious, burning intensity that Bevvins would have found unnerving had he thought to look around.

When Gresham returned, dejected and gloomy, Thad Frye broke in on Bevvins' seeming reverie. "How much time's left, Clancy?" he asked quietly. "I'd like to write some letters."

"What?" Bevvins looked startled. "What was that?"

"How long . . . before—"

"No, no!" Bevvins realized that he was shouting. He lowered his tone. "No, let's not strike ourselves off until we've exhausted every possibility," he said earnestly.

"But—"

"Lee, how soon can we expect relief from Ganymede? After they receive our distress signal, of course?"

Gresham had been forlornly shucking off the emergency p-suit. He paused. "I'd say forty to fifty hours, if Ganymede's on their toes, and everything goes smoothly."

"I . . . see. Do we, er, have that much time? Before crashing down into Jupiter's atmosphere, I mean."

"Oh, hell yes! The mild nudge that lox rupture imparted won't affect Zipper's orbit for hundreds of hours. I didn't take time to make any doppler readings, but—"

"What blessed *difference* does it make?" demanded Frye, as close to anger as either Bevvins or Gresham had ever seen him. "We have to *breathe* until they grab us!"

"Er, yes; I hadn't intended to broach the subject just yet, but . . . perhaps we do have something to breathe."

Gresham looked puzzled. "What the hell do you mean?"

"Precisely what I said," announced Bevvins cryptically. "By the way, did you manage to look in on my animals, Lee?"

The astronomer groaned. "Yeah, they're O.K., doc. It's one helluva time to be worrying about *monkeys*, though!"

"It may be very important," said Bevvins. "*Very* important. If Bess is still alive and well, we may have a chance. It's a slim chance, and will seem absolutely far-fetched to you. But, *any* chance is better than none."

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"We sure won't argue that point," said Frye, tight-lipped. "Get it off your chest, Clancy."

Bevvins cogitated. He took a deep breath; the air in the compartment was still untainted. "Thad, you and I were ribbing Lee, earlier, about his secret government project. I've a confession to make: I have been working on a similar assignment under similar restrictions for almost six years.

"Lee was also quite correct in guessing that Ganymede Base—or Luna, or Earth, for that matter—would have been a much more proper site for biomedical research than Zipper One. You see, neither solar radiation levels nor zero-gee have anything whatsoever to do with my work."

Bevvins hesitated. "The real reason our security chaps insisted that I engage in here with my gibbons was on the latter isolation it afforded. Here at Zipper One, I've been surrounded by gentlemen like [illegible] physical scientists of one description or another. There is not one biomedic, nurse or medical scientist nearer than Ganymede Base."

Frye licked his lips as if he were about to say something, then decided against it. Lee Gresham frowned. Bevvins uncertainly. "Go on."

"I expect if another medic had had occasion to look in on my laboratory, he would have noticed something damned peculiar," said Bevvins. "Hector—he's the duff-colored fellow in the leftmost wire cage, Lee—lives as we do in the air supplied by our now defunct life-support system, while Bess, the black and tan girl, is in the bubble cage under glass. If you'll think about it, you may remember that no air ducts run to that bubble."

"No, I . . ." Gresham shrugged. "Do you mean the monkey with all the wires attached to it?"

"That's her. For three months, Bess has lived and prospered while sealed off from the ambient air of the lab, surrounded by nothing less than the carbon dioxide product of her own metabolism. I've broken the seal only to water and feed her, and to clean her cage." Bevvins waited while the others digested what he had said.

Gresham frowned. "I don't get it."

Frye coughed politely into his cupped hand. "It sounds impossible, Clancy. There must be hair growing in it someplace, or you'd be prepping us for surgery, or whatever, right now. Carbon dioxide, huh? How do you do it—an enzyme?"

"I say! That's an excellent guess, Thad," congratulated Bevvins. "If they were here, the security people would fret about you. I discovered Bevvinase—classified documents refer to it as Bevvinase, so perhaps the name will stick—while doing some work on oxidation, er, the manner in which cells use oxygen.

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Actually, the theory had been proposed in any number of earlier papers: an enzyme which would convert carbon dioxide to oxygen *en vivo*, as do plants. Someday, we hope to eliminate thoracic breathing entirely, effecting at least partial human adaptation to the spatial environment. But, for our present dilemma, trying to emulate Bess is our best and, it would seem, *only* hope."

"*Trying* . . . to emulate Bess," faltered Gresham.

"I'm afraid so. The 'hair' Thad mentioned does exist. You yourself noticed the way Bess is wired, Lee. She's monitored constantly for phrenic nerve activity, hemoglobin oxygen and carbon dioxide content, turnover rate, oxygen diffusion rate, and a number of other vital functions."

Gresham was earnest. "What does 'turnover rate' mean?"

"The enzyme's regeneration rate in the tissues," explained Bevvins. "Bevvinase becomes self-perpetuating when the coenzyme, which I've labeled . . . Oh, we've no time to get bogged down in a morass of medical detail. In simplest terms, enzymes are a form of pure protein substance which cannot be synthesized. Hector is my Bevvinase factory; Bess my subject—my 'patient', if you will."

Frye smiled for the first time since the accident. "Get to the hair, Clancy. What's the problem? It will get stuffy in here by-and-by."

Bevvins cleared his throat. "There are two enormous tufts of hair," he said. "One: while wonderfully useful as analogs, gibbon monkeys are most definitely *not* human beings. God, there are so many, many unknowns! I shan't be able to devise any sort of control at all, and I shall have to guess at dosages for each of us. And, if I'm wrong . . ."

"Guess good, Clancy. What's the other?"

"Homeostatic control mechanisms in the body," Bevvins said. "There are interesting push-pull phenomena called the Bohr and Haldane effects: carbon dioxide and oxygen work together because of some unique and fascinating properties of hemoglobin. Adding carbon dioxide to the blood tends to drive out oxygen, helping deliver it to the tissues, whereas adding oxygen helps drive out carbon dioxide through respiration. There are specialized nerve cells called chemoreceptors which constantly readout blood composition to the central nervous system, chemically controlling breathing. Bess has surgically implanted instrumentation which allows me to make certain adjustments. With ourselves, however, it will be hit . . . or miss."

"Whoo-o-o-ie!" Gresham waxed his hands. "We're home free!"

"Please, Lee," said Bevvins worriedly, "I've tried not to paint too rosy a picture. I've oversimplified everything awfully. We are far

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from being out of the woods, believe me."

Gresham stared at the physiologist. "You mean, you're not sure it will work?"

"Oh, not at all certain, no. Not with us."

Chad Frye beamed. "Why are you quibbling, Lee? If the odds were ten million to one, we'd still have to chance it."

"Are the odds that high?" Gresham wanted to know.

"Oh, by no means! I should say the odds are no more than two to one. Eight to five would probably be closer."

Gresham hesitated. "For, or . . . against?"

Bevvins sighed. "If I were less than honest Lee, I would tell you the odds favored us. They do not."

No one said anything for a dozen heartbeats. Bevvins pondered Jupiter, avoiding their eyes.

Then Gresham laughed. It was a brittle laugh, tinged with hysteria. "What the hell are we waiting for? Lead us to it, doc; I can't wait to find out if your crazy jungle juice works!"

Bevvins ordered Gresham to bring three EVA-rated pressure suits up from the air lock service area, explaining that they would later need them to insure re-inspiring concentrated carbon dioxide. Bevvins went along with Gresham as far as his laboratory in the C deck quadrant opposite the commissary. He unlocked the refrigerator and withdrew a small vial of colorless fluid. He wrapped it securely in linen batting and zippered it into the slash pocket of his jumpsuit, then floated for a moment near the animal cages, watching the chattering gibbons.

Hector and his friends in the wire cages loved weightlessness. Each had a distinctive personality, and Bevvins had learned to know them well—Polly's grumpiness, Robin's avarice, Portia's agile grace in flying to and fro in the larger cage.

"Can't have you suffering, can we?" he muttered sadly. "Not enough to go round, I'm afraid." He selected a syringe and filled it, his hands trembling ever so slightly. Soothing them one by one, he did what had to be done quickly and efficiently. There were tears in his eyes when he finished.

He went to the acrylic bubble, in which a black and tan gibbon reposed. "You'll do, Bess," he mumbled, reading the bioinstrumentation displays of a tan electronic console. "Sleep, girl; we'll have you out of here in a jiffy. If we are very, very lucky," he added thoughtfully.

Bevvins stopped by the infirmary and got out a sterile syringe boxed in a plastic tube. He put it in his bag, selected three tips, then pulled himself along the freefall line to the elevator. He met Gresham and Frye in the living quarters.

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"First, a sedative," Bevvins said. "We will want to remain absolutely immobile. Excitement, or even mild exertion, could induce hypernea—rapid breathing. My scheme is to inoculate you both, then monitor your progress as best I can until it's time to close your fishbowls."

Gresham swallowed noisily. "Can't say I like the sound of it much," he said.

Thad Frye grinned. "Just one more astrophysical vicissitude, Lee. It's like growing old. Being my age isn't so bad, when you consider the alternative."

Neither Bevvins nor Gresham cracked a smile. Bevvins administered sedative to each, then checked blood pressures, pulse rates, and oral temperatures. He asked for their respective mass-weights and ages in both years and months.

When all was ready, all three men donned the cumbersome, radiation-shielded p-suits. Thad Frye allowed Bevvins to loosely affix the restraint straps binding him to his bunk. "Sock it to me, Clancy," he said cheerfully.

Bevvins performed some calculations on a note pad, then prepared a syringe, and administered Bevvinase at Frye's wrist.

Gresham watched, round-eyed and apprehensive, as Thad Frye's chest heaved normally for three or four minutes. Then the physicist lapsed into very shallow breathing.

"First surge of Bevvinase." Bevvins grunted something else under his breath. He did some additional calculations. "Bess was comatose for the first dozen hours, or so, Lee. Please don't fret about Thad's breathing. He seems to be taking hold rather well."

"You're . . . sure?"

Bevvins tried to make his smile reassuring. "I'm sure. We won't close his fishbowl just yet."

"Are you . . . ready for me, now?"

"Yes, Lee. On the bunk, if you will."

Bevvins watched the astronomer closely. Gresham was very nervous, but the sedative was beginning to take effect. "There is no particular hurry," he said. "We can talk for a while, if you'd like."

Gresham's half-smile was drowsy. "Naw, doc. Like Thad said: sock it to me."

Bevvins attended to Gresham gently. He shoved himself away and took up the note pad, writing furiously for many minutes. He looked up at the chronometer now and again, checking their respiration rates. Finally, he decided it was time. He examined Frye exhaustively, then pulled down and sealed his fishbowl. When he had finished writing, he drifted over and did the same for Gresham.

The moment of truth had come. Bevvins had not taken sedative for a very good reason. He would have to stay conscious long enough to close his own fishbowl at the ap-

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[illegible] appropriate time. Timing was very [illegible] if he sealed himself off [illegible] the remaining air in the living quarters too soon, he would die of [illegible] before the Bevvimask could [illegible] hold. He had not seen fit to [illegible] this to the others.

Clancy Bevvins readied himself [illegible] the bunk. Smiling secretly, he [illegible] his fingers, daubed his wrist [illegible] and injected himself.

"He's coming around," someone [illegible] far away. "Look!"

Dr. Bevvins opened his eyes. He blinked several times, lifting his head. Lee Gresham was grinning at him from a hospital bed across the [illegible] compartment. Beside him, [illegible] himself hugely, stood the [illegible] figure of Thaddeus Frye.

"We [illegible] you keeping, [illegible]" The black physicist walked to his bedside with a springy step, clasping his hand. "We did it! You said you could [illegible] and by God, you did it!"

Bevvins smiled thinly, still fully occupied by the process of reviving. "We seem to have made it, at [illegible]," he said.

"And how!" Gresham bounced on the bed. "Weight! Feel it? Now that you're awake, doc, see if you can help bust us out of quarantine. They come in here and feed us and look us over dressed in pressure suits like coveralls—fishbowls and all. You'd think we were contagious."

Bevvins used his arms to slowly erect himself into a sitting position. Thad Frye fluffed the pillow behind him. "I'm damned glad they read my instructions," Bevvins said. "If they hadn't—"

"Instructions!" Gresham swore. "We're on Ganymede," he insisted. "I want my clothes. I'm going for a romp down the midway, and maybe chase a stewardess or two. Most of all," Gresham said fervently, "I want my *pipe*."

Bevvins coughed politely. "Lee," he said, "there is simply no way of breaking it to you gently. The stewardesses will have to wait, I'm afraid. As for the pipe, it wouldn't be of any use to you, now."

"What? What do you mean?"

Bevvins considered his answer carefully. "In Zipper One, I had only one patient—Bess," he said. "Now I have four: Bess, Thad, you . . . and myself. Remember what I told you back there in Zipper's commissary: the enzyme is self-regenerating. All of us have become *true* spacemen. At least, for the time being."

Thad Frye met Bevvins' inquiring look. "Yeah, I guessed it, Clancy," he said. "I thought maybe it would be a good idea if you told him yourself."

"You mean . . !" Gresham's jaw dropped. He studied them with an agonized expression, looking as if he were about to cry.

"What a lousy, rotten way to quit smoking!" was all he said. ■

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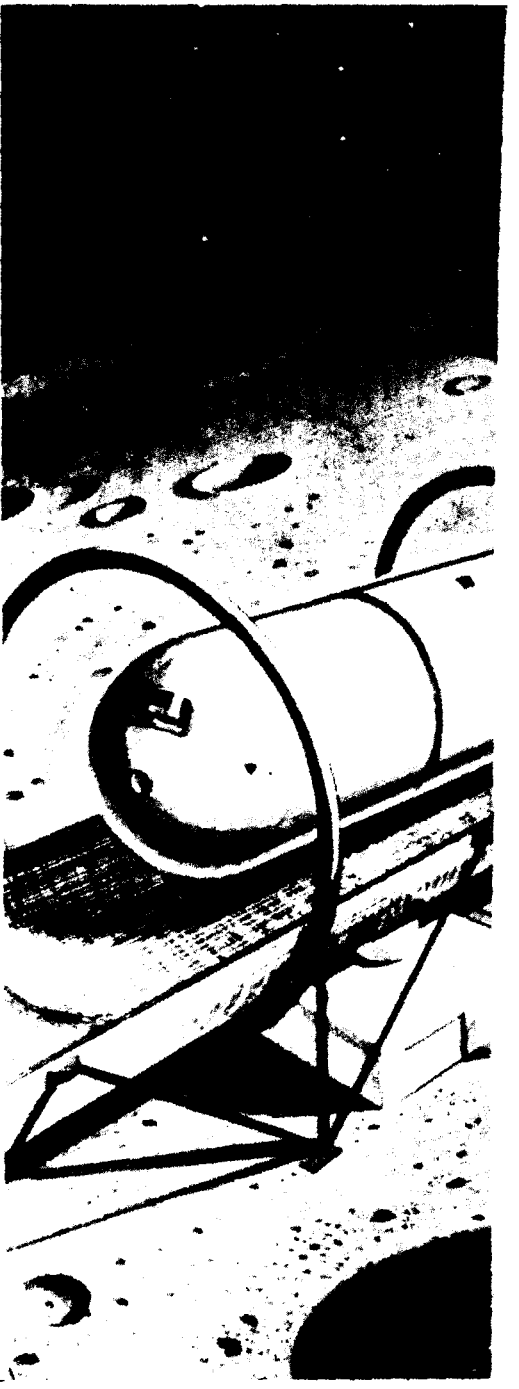
G. HARRY STINE

The 3rd Industrial Revolution



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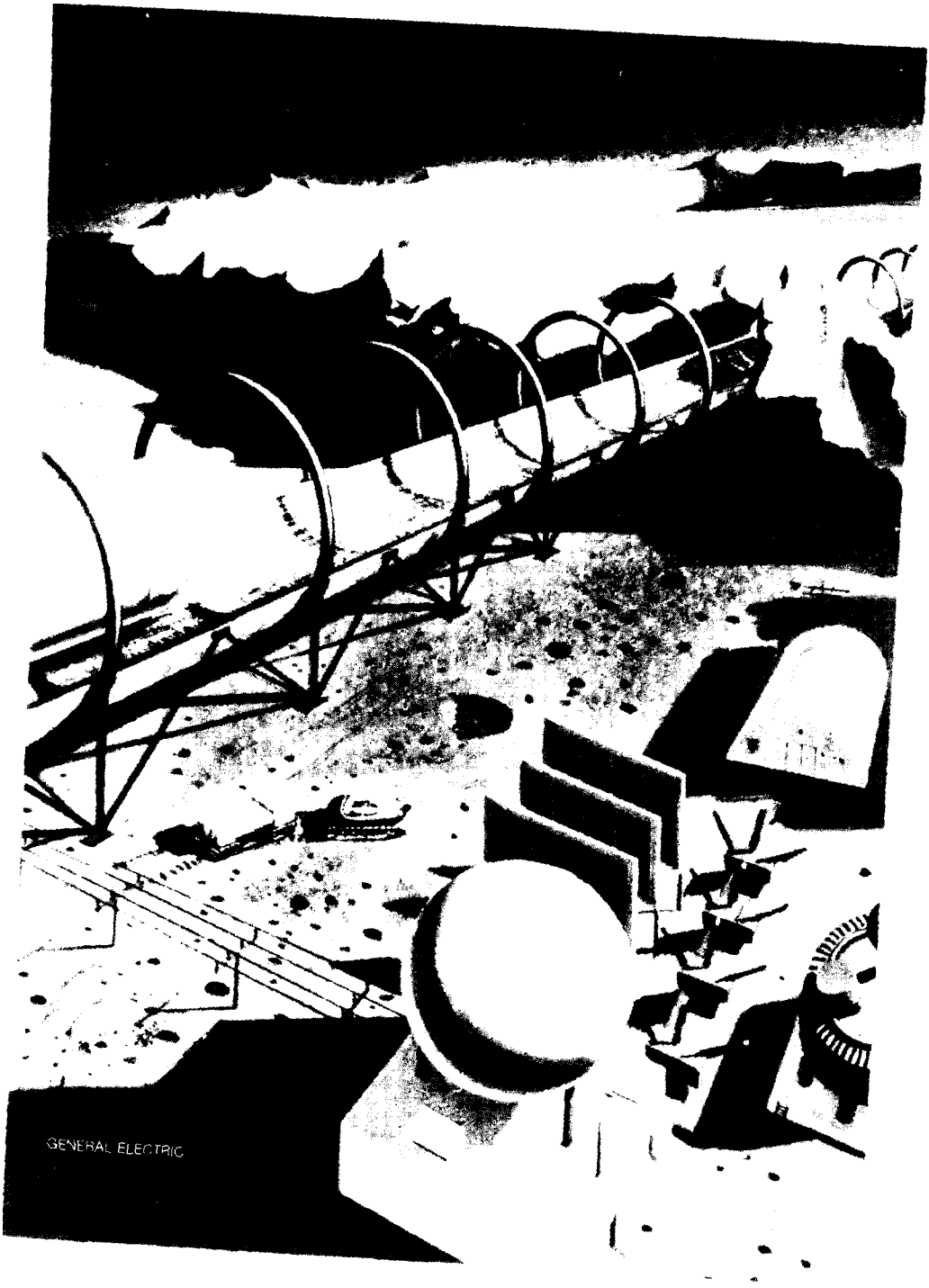

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Conclusion.
When you want to have your cake and eat it too, you're in a dilemma. When you want to continue a high-level technology without further gutting Mother Earth for resources, you have to move your industrial base out of this world.

Industrial processes depend upon the availability of both raw materials and energy. Happily, the space environment has both. Since at first it will be far too expensive to bring raw materials up out of the terrestrial gravity well of 11.2 km/sec, we will have to obtain them from shallower gravity wells. Initially, this could well be the Moon with only a 2.4 km/sec gravity well. However, it is quite likely that the prime source of raw materials in the Solar System will be the planetoid belt, and there has been considerable discussion about this possibility in these pages and elsewhere. Later on, and in spite of a gravity well of 61.0 km/sec, the planet Jupiter will be tapped for raw materials.

Note that the figure of difficulty for transporting raw materials around the Solar System is given in terms of velocity change, not distance. And transit time has no bearing on the cost. The true cost of lobbing raw materials around in space is a function of the cost of converting chemical or solar energy into the kinetic energy of velocity. Even if we come up with a reactionless space drive, it will require converting energy. The big cost of cosmic mining operations is that of getting human beings out there and maintaining life support while they are directing operations. The raw material itself will be sent to the space factories by the cheapest possible method. This means interplanetary trajectories requiring the least amount of energy. Lob a load into the proper trajectory at regular intervals, and pretty soon you have an astronautic pipeline with loads coming into the space factory with great regularity. Once such a pipeline is established, it makes little difference how long a given load stays in transit; all that matters is the constant delivery rate.

Even delivering raw materials

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from the Moon is not going to be an expensive thing. The Moon is a body with no atmosphere and with an escape velocity of 2.4 km/sec. We can use solar energy to generate electricity to power an electromagnetic lunar surface catapult capable of heaving quite sizable loads into space. Even energy losses in this device do not cost us. The only cost is depreciation of the capital equipment and the expenditure of the steel cans used to house the raw material loads to permit them to be catapulted. This sort of thing should be old hat to most SF readers who have cracked the covers of Heinlein's "The Moon Is a Harsh Mistress" or any number of other stories in which a lunar catapult has appeared. We could produce the engineering drawings for such a device today.

No, the technical problems of shipping raw material around the Solar System are not formidable and the costs are reasonable. The technical problems lie elsewhere: with us, with the human beings who must be there to run things. We must be there because it takes too long at the speed of light for radio commands and telemetry to span the distances involved; remote control becomes highly impractical and it becomes cheaper to put people there.

At the moment, the technical problems involved in designing, building, and maintaining long-life space-going closed ecological life-support systems prevent us from immediately mining the planetoids or Jupiter. But we can look forward to the solution to this within the next twenty-five years.

As we have seen in Part One, there is also plenty of energy available in the Solar System.

But there are interesting little engineering problems concerned with proper handling of energy in the space environment. We have not had to worry about these problems on the Earth's surface . . . yet. But we will have to before very many more years have passed, because the most important problem that we are facing on Earth—and will face in space—is one of heat balance.

Heat balance? Why worry about it? Tap the city mains or the local river for cooling water. Build cooling towers to dump the excess heat into the local atmosphere. Discharge the hot coolant into the river or ocean. The atmosphere and the oceans are pretty good heat sinks . . . and they are big.

Our energy-use levels have, until recently, been low enough that engineers could take the easy way out (as they always do, quite properly so, by training). They simply dumped hot gases into the atmosphere and hot water into the rivers and oceans. They probably could have done it for a much longer time if they hadn't also dumped waste matter at the same time. People began to get upset when

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millions of fish went belly-up and when they discovered they couldn't see across the front yard because of smog and tears in their eyes. So industrial engineers are becoming increasingly sensitive about heat balance, efficiencies, and the like.

These are going to be very critical in the space environment, but for a different reason.

There is a very, very large heat sink out there, and it will take more than we can put into it for centuries to come. But our little world, the space factory, is going to be a very small heat sink.

In a space manufacturing operation, every little bitty calorie is going to have to be watched. Every calorie coming in is going to have to be accounted for, it's going to have to be watched while it is there, and it is going to have to be disposed of on schedule. The *only* way to dump excess heat from a vehicle in space–other than by overboard dump of coolant, which must then be replaced–is by radiation.

Space factories using the high energy levels and densities available "out thar" will have to have lots of radiator area to discharge the inevitable waste heat into the sink of the space environment. Insulation only delays the problem of dealing with waste heat, although engineers will use insulation to provide heat "delay lines" in the space factory, perhaps to smooth out heat pulses or peak heat loads so that they can be more easily handled.

Space industry heat radiators will also be much larger than required. Engineers simply refuse to eliminate a thing they call "safety factor." They will deliberately overdesign and over-build by a factor ranging from two to ten, depending upon the magnitude and seriousness of the consequences if something goes wrong. This does not mean that they have no confidence in their work. It is their statement of reality because they know good and well that sooner or later (a) somebody is going to goof, forget instructions, panic, or try to stretch the design, and/or (b) something in the system is going to malfunction. They've humorously tagged it "Finagle's Law" and it states that "anything that can go wrong *will* go wrong." To prevent a heat surge from turning the space factory into a white-hot glob, they will try to anticipate overloads by building the heat radiators larger than required or by making stand-bys available.

Yes, we are talking about very large structures and very large heat fluxes. But engineers are not boggled very often or for very long by big numbers. They are even more blasé about big numbers than astronomers. And they are working in a strain-free environment.

They'll handle the heat balance because they will have to. Even now, a number of industrial processes are being considered for space, and they require heat sources.

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In space, there are three basic sources of heat energy:

1. Solar radiation
2. Nuclear reactors
3. Chemical reactions

Right off the bat, chemical reactions might seem to be ruled out. But this is because our minds are still earthbound and thinking only about fuel-oxidizer exothermic reactions. Any sharp chemical engineer will advise you that there are other ways to get chemical heat. For example, be very careful not to burn yourself when you make up a solution of zinc chloride and water; the solution gets pretty hot. Fuel cells may also be considered in the category of chemical reactors, and these are already being used in space exploration. The big problem with chemical reaction heat sources seems to be the amount of matter required and the fact that there is waste matter left over . . . water in the case of oxy-hydrogen fuel cells. However, it might be possible to recycle the water from fuel cell operation by using solar radiation to break up the hydrogen monoxide molecule.

It would also seem obvious at first glance that the chief contender for heat energy would be solar radiation. After all, it's out there for the taking. Or is it? No, not always for a space factory located in a 200-kilometer equatorial earth orbit it ducks into the earth's shadow for a significant portion of its orbital period. Same problem as using solar radiation as a sole power source here on earth, except the day-night cycle is shorter in the 200-kilometer orbit. The answer, of course, is to put the space factory into a polar orbit; it is only incidental that more energy is required to put it there and to get to it from the surface *and* from deep space. Ruzic cryostats and factories on Luna are going to have to have an energy source to substitute for solar radiation every fourteen days. Obviously, there are earth orbits into which a space factory can be placed where there is constant solar radiation; these are far out and at a slight angle to the ecliptic so that they get neither terrestrial nor lunar shadow. Thus, except for close-in orbits, solar radiation remains as probably the best energy source . . . even though you have to go to the bother of keeping your solar radiation receivers pointed toward Sol.

On-board nuclear energy sources are small, compact, constant, and reliable. They are also damnably inefficient at this point in time with only faint hopes of improving the situation in the foreseeable future. However, because nuclear units have such excellent characteristics, engineers will apply their philosophy of "don't fight it, love it." If nuclear reactors produce lots of heat directly, use it directly instead of trying to convert it all into electricity. Yes, nuclear reactors do also produce ionizing radiation that isn't

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exactly healthy to living organisms in large doses. But they have been powering submarines with them for well over a decade. Submariners have been living with nuclear reactors practically in their laps. It does not appear that the birth rate in New London, Connecticut has fallen in the slightest. Nor do the girls put away the pills when the U.S.S. *Enterprise* makes port.

Each of these three energy sources has its own advantages and disadvantages. We will be using all three of them in our Third Industrial Revolution space factories, each in specialized applications where their good points come out tops in the trade-off.

At the moment, the most efficient means for utilizing the output of any of these three sources appears to be in the form of electricity. Electricity is easily generated by all three sources. Electricity is easy to handle, transmit, control, measure, switch, and use.

NASA has studied several promising electrical heat sources for space industrial processes. These are:

1. Induction heating
2. Electron beam gun heating
3. Electron beam plasma gun heating
4. Laser
5. Electric arc
6. Electrical resistance heating
7. Ultrasonics
8. Microwave heating

Some of these can be used in a vacuum—and, in fact, must have a vacuum in order to work—while others require an atmosphere. Electric arc heating is one of those that will not work in a vacuum and must be subsidized by an atmosphere in order to strike the arc.

You might think that a laser would be an excellent industrial heat source for space. Perhaps for some very specialized applications. But not generally. According to unclassified sources, the best efficiency attained thus far in high-power CO_2 lasers is a roaring fourteen percent—which means that you've got to handle eighty-six percent waste heat somehow.

Heating by ultrasonics also falls into this category: poor efficiency. In addition, this process requires friction, the actual rubbing of materials together. In the zero-g environment, this could well be a serious drawback.

Microwave radiation heating has poor heat efficiency and poor weight efficiency. In addition, it's molecularly sensitive. Microwave ovens work because they excite the water molecule in foods . . . and other organic materials such as your hand if that happens to get in the beam. Yes, if you get enough beam power, a high enough energy density, you can heat lots of things . . . like vaporizing a ball of steel wool thrown into the beam of a megawatt missile tracking radar.

The electron beam gun turns out

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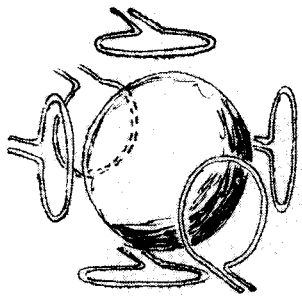

FIGURE 1. Electromagnetic "levitation" and heating of metals in zero-g can be accomplished by application of radio frequencies to coils surrounding the sample. Heating is accomplished by induction, and positioning and handling is carried out by varying the r-f in the coils.

be very good as a space industrial heating source in a vacuum. It has very good heat efficiency and high energy density. It can be focused down to get things very hot quite locally.

But the electron beam plasma gun has no definite advantages over the simpler, ordinary electron beam gun. It's more complicated. But it may be used in special processes where specific beam particles are required.

Induction heating comes in with a score of seventy percent efficiency and if the material is magnetic can be used to levitate, position, and move the material as well as heat or melt it. It is also possible to get very high temperature gradients with induction heating. (See Figure 1.)

The very best heat source for space industrial processes in terms of thermal efficiency, weight efficiency, cleanliness, and adaptability to the space environment—especially vacuum—is electrical resistance heating. The good old electric stove turns out to be the best heating source for space industry!

Please note that none of the above heating methods involves the use of a flame created by the combustion of a fuel and an oxidizer. This is not because we would have to transport the fuel and oxidizer to the space industrial site. It is because the weightless environment does not permit the existence of a flame as we know it.

The familiar candle flame in a one-g field is shown in Figure 2. It results from burning the paraffin hydrocarbon of the candle with the oxygen in the ambient air. It is a steady-state process once it is initiated. Several events occur very rapidly in the flame region. Combustion specialists are still not exactly certain what happens when and where, and the simple flame turns out to be another common and apparently simple device, like the electrical transformer, that is very difficult to understand. It appears that the solid material of the hydrocarbon is first melted, then vaporized by the heat radiated

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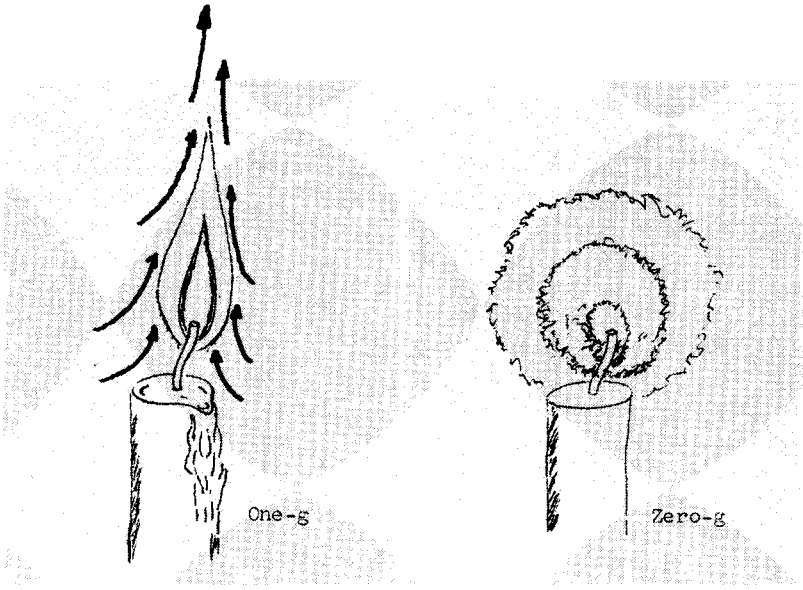

FIGURES 2 and 3. Behavior of a flame is greatly different in our normal one-g environment (Figure 2) from that in the zero-g of space (Figure 3). On Earth, the heated gases from the flame are less dense, therefore rise and pull in fresh oxygen for the flame. In zero-g, there are no convection air currents formed, and the flame surrounds itself with combustion products.

from the combustion zone; this absorbs some of the heat energy of the system. These gases then react with the surrounding ambient oxygen, and the resulting oxidation reaction releases enough heat energy to drive the system and perpetuate this chemical chain reaction. Combustion product gases are formed by this reaction and include carbon dioxide, carbon monoxide, water vapor, and numerous minor combustion products ranging in complexity from hydrogen to large organic molecules. Specialists in flame structure and combustion processes believe that many of these compounds, including the simpler ones, are formed through various stages that involve free atom and free radical production and reaction.

The resultant low density hot combustion end-product gases rise from the flame zone since they are less dense than the surrounding atmosphere. This permits atmospheric oxygen to enter the flame zone to perpetuate the process. Although flame combustion is therefore a very complex process with many intermediate steps, it is a steady-state process in which gas flow and fuel flow into the system can be equated with gas flow out

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plus heat energy . . . in a one-g field

If the candle and flame are placed in a zero-g environment, the lower density combustion end-product gases do not rise away from the flame zone. They can't. In the absence of a gravity field, less dense gases cannot rise. Therefore, fresh atmospheric oxygen cannot move into the flame zone to perpetuate the combustion process.

An idealized zero-g flame shortly after ignition is shown in Figure 3. Some studies have already been made with zero-g flames in jet aircraft flying parabolic trajectories. High speed cine films have been made of these experiments. They show some interesting and, at first, confusing results.

Initially, the flame builds up to maximum size and brilliance very quickly. Then, just as quickly, it recedes and darkens. In actuality, the zero-g flame never achieves the full envelopment shown in the idealized sketch because the ignition method localizes the burning to a few spots. In addition, the combustion products tended to subdue the flame before the fuel-wick system could be enveloped in toto.

But the zero-g flame process did not stop!

When acceleration returned at the end of the parabolic zero-g flight, the flame reappeared.

This is an example of the sort of totally unsuspected and highly serendipitous sort of thing that we may expect in our transition from earthbound conditions to those of space.

Naturally, this strange flame behavior immediately invokes scientists to form hypotheses to explain what happened. One of these hypotheses goes as follows:

The gas that is formed from the fuel by heat energy reacts chemically with the atmospheric oxygen. But, unlike the steady-state fuel-to-air mixture ratio of a one-g flame, the zero-g flame experiences a constantly changing mixture ratio. It goes from very lean to very rich as the ambient oxygen originally surrounding it is chemically used up. The process occurs much faster than ordinary diffusion can replace the oxygen, and oxygen starvation occurs. The flame immediately begins to cool. The result is a blanket of fuel-rich flammable gas next to a molten fuel that is in turn covered by a layer of both solid and gaseous combustion products in a fuel-rich state. These multifarious combustion products probably include free radicals and free atoms, plus a lot of very fuel-rich components . . . *plus* heat energy that has not been able to leave the party by convection currents of the combustion gases. The heat energy stays in the system, leaving only by conduction through the unburned fuel to the candle, in our example, or by radiation from the corona of unburned components.

The zero-g flame system can best

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be described at this point as *dormant.*

When convection is renewed by either acceleration of the system or by fan-induced air movement, the gases are cleared away, oxygen is provided to the starved system, the complex free radicals and free atoms begin to react, and the combustion process is renewed.

How long will a zero-g flame remain dormant? The aircraft tests provided only enough weightless time for a maximum of twelve seconds "float" for the zero-g flame . . . which is plenty of time to study it, sample the gases and compounds within the dormant flame, and measure it six ways from Sunday. The flames remained dormant for as long as the twelve-second float.

This is not only plenty of time to study a zero-g flame with modern high speed instrumentation, it is also plenty long enough for hypothetical, yet-to-be-devised industrial processes that will tap a dormant zero-g flame to obtain some very unusual chemical compounds obtainable in no other way!

We are going to run into other amazing and serendipitous discoveries in the space environment. Obviously, because of our one-g mental orientation, we haven't suspected all the zero-g possibilities in reasonably common phenomena. Most of these discoveries will be quite elegant in their simplicity and will cause us to exclaim, "Why, of course! Why didn't we think of it before?"

The reason is simple: We have a distorted notion of the way the universe works.

But we do not need to base our speculations about what space industry can do on things that we might or might not discover to be possible once we are firmly entrenched in the space environment. We do not need to say, "We must do it because we don't know what will be discovered until we do." The people who are interested in the possibility of space industry are doing their homework in advance. They have already identified a number of industrial processes that appear to be quite viable, unique and economical in space.

The table on page 105 shows in outline form some fourteen different generalized industrial processes amenable to the space environment. These include some forty-four different subheads which are distinct processes themselves. Synergistic combinations of these lead to an astronomical number of possibilities. This means that we are going to be able to conduct a very diverse number of industrial operations in space.

Some of these have been discussed at length here and elsewhere. See, for example, Joseph Green's article on "Manufacturing in Space" in the December 1970 issue of Analog. A number of space industrial products, some obvious

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SPACE INDUSTRIAL PROCESSES

(Adapted from Wuenscher)

1. Free and Captive Suspension
   a. Crucible support, wetting and non-wetting
   b. Sting support, wetting and non-wetting
   c. Electromagnetic field support
   d. Electrostatic field support

2. Mixing
   a. Mechanical
   b. Induction
   c. Benard Flow

3. Separation, Purification
   a. Centrifugal, free or container
   b. Velocity separation, condensation or selective membrane
   c. Electrophoresis
   d. Magnetic separation
   e. High-vacuum refinement, Centrifugal or Marangoni Flow

4. Alloying + Supersaturation
   a. Pre-mixed powders melting
   b. Thermo-setting or diffusion alloying

5. Casting
   a. Surface tension casting or free casting
   b. Supersaturated alloy casting
   c. Composite casting, 2-state or 3-state
   d. Adhesion or layer casting

6. Liquid State Forming
   a. Blowing
   b. Electrostatic field forming
   c. Adhesion or surface tension drawing

7. Controlled Density Processing
   a. Dispersion foaming
   b. Vaporization foaming
   c. Variable density casting

8. Deposition
   a. Adhesion coating
   b. Galvanic plating and coating
   c. Vapor deposition

9. Solidification
   a. Amorphous solidification
   b. Controlled crystallization
   c. Single crystal solidification
   d. Supercooled coining
   e. Zone refining

10. Melting
    a. Complete melting; low/high viscosity, overheated
    b. Partial melting; matrix melting in cermets
    c. Low-melting intermetallic; thermo-setting alloys

11. Vaporization
    a. Fractional distillation
    b. Pressure-drop vaporization
    c. Freeze-drying

12. Nuclear processing
    a. Fission breeding
    b. Fusion breeding
    c. Irradiation

13. Chemical Processing
    a. Polymerization
    b. Free atom chemistry
    c. Free radical chemistry

14. Fermentation

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and some not, have also been discussed. Since it is quite impractical here to cover the remaining ones on the chart that have not received attention, let's just look at a few of the more interesting processes and see what comes from a study of their possible uses. Mind you, the obvious products probably will not be the most ubiquitous or most profitable ones to come from any given process. And there are combinations of processes that could produce some interesting products. Remember that we are standing in the shoes of a hypothetical Benjamin Franklin just after the opening gun has gone off for the First Industrial Revolution; could Ben or any other intelligent and informed person have forecast all the products that would ensue?

Also please remember that we are not just talking about the "early days" of space industry between now and the turn of the century. We are looking at all the possibilities with assumptions of deep space transportation rates being comparable to today's ocean-going shipping tariffs. We are also considering using raw materials that we are going to find in space and on other planets with shallower gravity wells.

Separation and purification of materials takes on a wholly different aspect when carried out in the space environment. For example, electrophoresis involves the use of electric field gradients to separate macromolecules. It is a very useful industrial tool here on Earth for biological production. But because of convection within the apparatus, we have not been able to widely use the simple, straightforward and highly efficient fluid electrophoresis. This has led to the development of paper electrophoresis, column electrophoresis, and electrochromatography; they are not as suitable for a number of reasons. In the space environment, the lack of convection cells created by density differences will permit the use of zone electrophoresis with liquids, which promises to produce exceedingly high quality biological materials.

The lack of convection due to density gradients in a fluid is an aspect of zero-g, by the way, that is just beginning to draw attention to itself. Surface tension and other internal forces are usually overpowered here on Earth by the presence of the one-g gravity field. In the space environment, the ascendancy of these formerly "weak" forces is a reality that can be used for industrial processing. There are two prime examples of surface tension phenomena that are of interest.

Very few people have heard of Marangoni Flow, but many people have witnessed it. Marangoni Flow is fluid flow caused by surface tension gradients. Surface tension itself is a function of both the temperature and the chemical concentration

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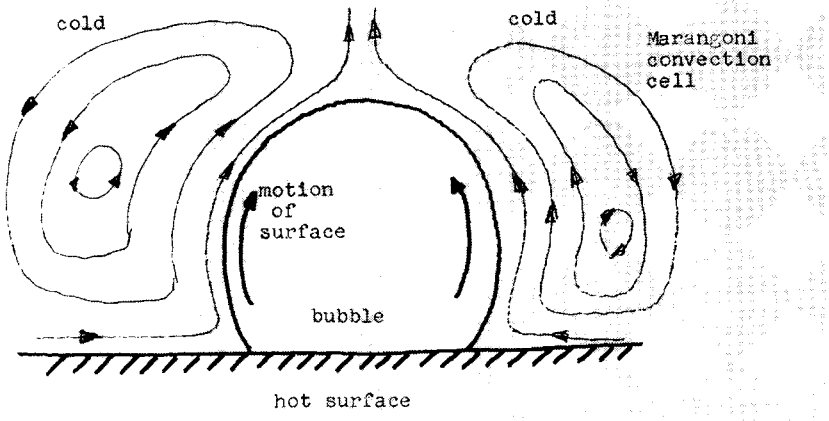

FIGURE 4 Marangoni Flow is a surface tension phenomenon caused by the movement of a fluid surface from an area of high surface tension to one of low surface tension. Surface tension gradients can be created by a difference in temperature or concentration.

of fluid. If a free liquid surface experiences a surface tension gradient because of temperature or concentration differences, the fluid will flow along its surface from an area of low surface tension to an area of higher surface tension. (See Figure 4.) A common illustration of Marangoni Flow is the formation of "tears" or drops on a wine glass. The evaporation of the alcohol in the wine leaves a cool layer of wine on the wetted side of the glass above the liquid level of the wine. This has a higher surface tension than the wine in the glass, so the liquid layer on the wetted wall draws up liquid from the bulk until a "tear" is formed. When the tear becomes too large and gravity forces again prevail, it runs back into the bulk of the wine in the glass.

Obviously, Marangoni Flow can be used to separate fluids of different surface tension, to pump fluids because of a difference in temperature, or to produce fluid flow under vacuum conditions. It will be predominant in the zero-g environment of a space factory. I am not going to make the same mistake here that Arthur Clarke made in his famous article on communications satellites: there are some patentable aspects to the use of Marangoni Flow in space industrial processes that I would not care to discuss for a couple of years

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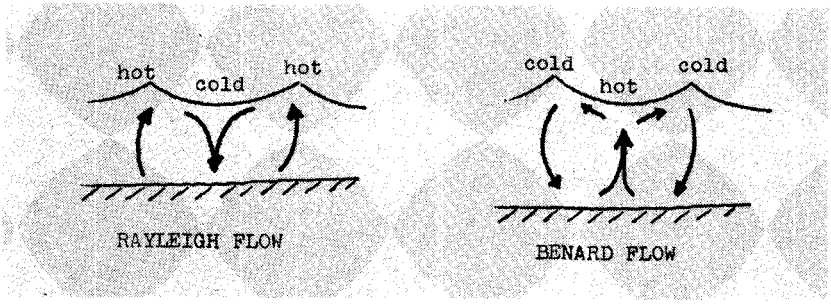

FIGURE 5. Rayleigh Flow is the well-known earthbound formation of convection cells by density gradients where the rising low-density fluid lifts the liquid surface. But in zero-g the only convective heating cells that can form will be the result of Benard Flow, a surface tension phenomenon where liquid flows from areas of low surface tension to areas of high surface tension and flows faster on the surface than within the fluid. Thus, Benard Flow lifts the fluid surface above the cold portions of the convection cell because surface tension increases with a decrease in temperature. It doesn't look right, but that's our one-g mental distortion at work!

in the public press, thank you.

Benard Flow is a variation of Marangoni Flow that is also a surface tension gradient phenomenon. It will produce convection cells in a film of liquid in the absence of a gravity field. Or even against a gravity field! If you have a thin layer of fluid and heat it on one side, cooling it on the other, you will establish cellular convective motion within the fluid independent of ordinary Rayleigh convection cells. Figure 5 shows the difference. Again, the fluid flows from an area of low surface tension to one of high surface tension, except that it occurs not on the surface of the fluid but within a thin film of fluid.

Don't get mentally blocked or problem-set with the idea that a fluid is something like a solution that exists at or near room temperature. Gases are also fluids. So is a melt of metal. In zero-g, it becomes possible to use separation techniques as purification processes utilizing either density differences or surface tension differences. Some density difference separation techniques are as simple as spinning-up a glob of fluid in free suspension. (See Figure 6.)

All of this leads to very high-purity materials that are formed free of container contamination. And it becomes quite practical to produce very large quantities of these super-pure materials. High-

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purity materials such as metals are usually very expensive now, mere laboratory curiosities as aluminum was in the early Nineteenth Century. Super-pure materials often have physical or chemical properties quite different from those of a slightly-impure material. Beryllium is an example of this. When produced on Earth from the double fluoride K_2BeF_4 by electrolysis, it is brittle and hard enough to scratch glass. When produced by vacuum distillation to get high purity, beryllium is quite ductile. What can be done with inexpensive, easily obtained, ductile beryllium? It's like asking a scientist in 1830 if he thought aircraft would be made of aluminum; both were impractical ideas at that time.

In addition to making high-purity materials in space, it will also be possible to make combinations of materials with highly-controlled alloying, doping, or contaminating. Alloy technology began with the first manufacture of bronze, a mixture of tin and copper . . . and it probably occurred by accident. Since then, all alloying has been basically the same: mix two or more molten metals together to achieve a homogenous combination, then let the mix cool.

Sometimes this doesn't work too well with certain metals on Earth,

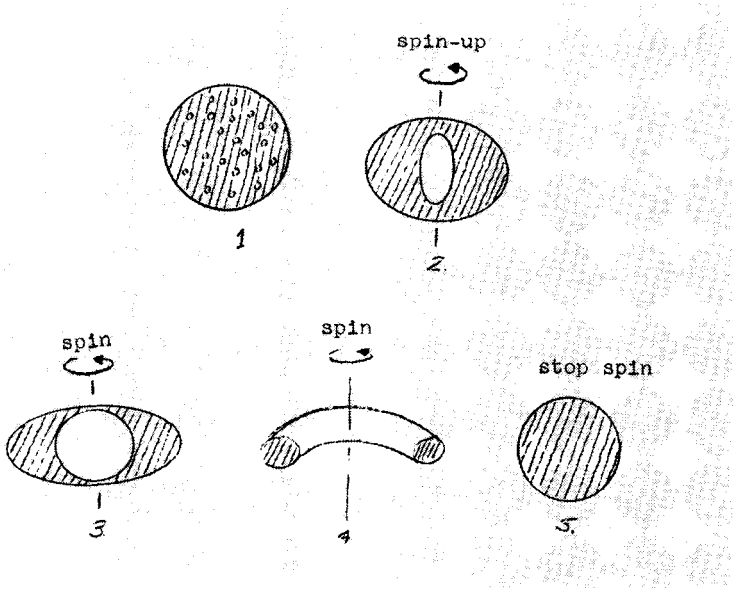

FIGURE 6. Degassing or density separation by the spin technique.

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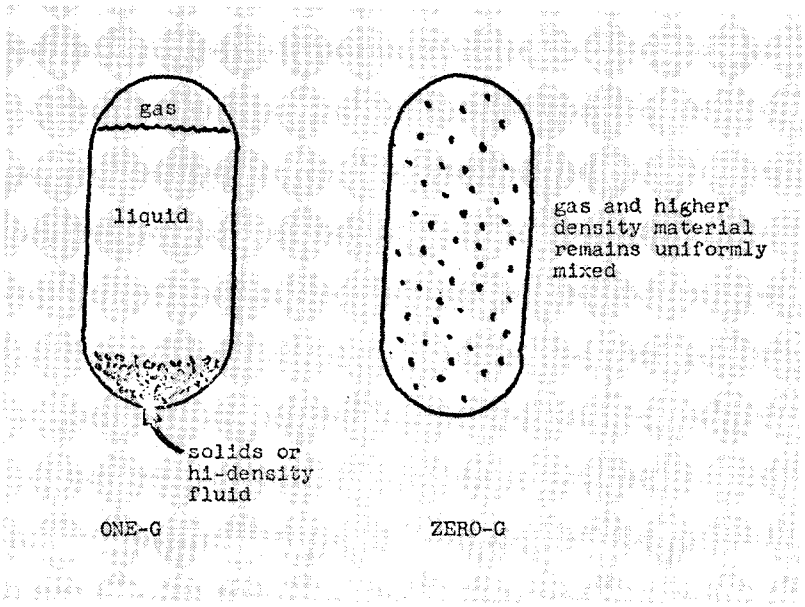

primarily because of density differences between the metals and often caused because their surface tensions are so different that they won't mix.

For example, gallium arsenide produced on Earth is a semiconductor used in light-emitting diodes, Gunn Effect avalanche diodes for microwave sources, and limited space charge accumulation devices. Bismuth is of the same period as arsenic but exhibits immiscibility with gallium. Experts believe it could be produced as a homogenous alloy in the zero-g environment; they do not know at this time precisely what its characteristics and properties might be, but they believe it might exhibit some interesting semiconductor properties.

FIGURE 7. It is possible to obtain a uniform, homogenous mixture of materials of different densities in zero-g and maintain the uniformity. Astronauts will be able to keep their oil-and-vinegar salad dressing well-mixed continuously with one good shaking.

The classic homogenous alloy process is not limited to metal systems. Any binary or pseudobinary alloy system which exhibits a liquid immiscibility problem should be capable of forming a homogenous alloy under space environment conditions. Some unique materials are going to result from this. It's too early to say for certain, but they

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will probably be cermet-like materials with several structural and electronic applications.

The space industrial environment is also going to make possible the first significant departure in alloy technology since the start of the Bronze Age. Most alloys have to be formed at high temperatures because of miscibility problems, among other things. However, for years dentists have used an intermetallic compound known as an amalgam—usually a mixture of solid silver and liquid mercury—a metal with a high melting temperature coupled with a metal with low melting temperature. It is also possible to form true homogenous alloys of a combination of a low-melting-point metal and a high-melting-point metal and then "cure" them at higher temperature. The big problem with these "thermo-setting" alloys in the Earth environment is the fact that they are very sensitive to mixture distribution homogeneity. But in the density-insensitive realm of zero-g, it will be possible to achieve and sustain exceedingly homogenous mixtures without concern that they will separate. (See Figure 7.) When we are able to make the first thermo-setting alloys in zero-g, we may be able to use them to form very interesting composite materials when combined with whiskers.

Whiskers themselves are going to become common for composite materials because it will be much easier to make them in zero-g. One problem with whiskers is the inability to grow them to great lengths in a one-g field; they break off. In addition, whiskers are most commonly formed now by growing them around a thin tungsten wire; this complicates the metallurgy of whiskers tremendously, lowers their potential strength, and places a lower limit on how small a whisker can be made. In zero-g, we will be able to form whiskers without the tungsten wire center and will be able to form them with very long lengths.

In the zero-g environment, we will also be able to produce very large, very thin membranes by means of surface tension drawing with no substrate support. On Earth, the production of ultra-thin membranes requires the use of a substrate to support the membrane against gravity forces. The substrate limits the thinness to which a membrane can be drawn because, after you have formed the membrane on the substrate, you have to strip it off the substrate.

Obviously, if you do not have to support the membrane against gravity, you can form a very thin membrane of very large area. It is rather like blowing a gigantic soap bubble or forming a very large soap film on a loop of wire. After you reach the size where the surface tension forces are overcome by the gravity forces, the membrane

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breaks. In zero-g, you can blow your soap bubble as large as you wish, deposit it on frames as shown in Figure 8, and then break the bubble in between the frames. This is but one method being discussed for formation of large thin membranes in zero-g.

Theoretically, it would be possible to form a membrane the size of a football field (or larger) with a thickness of only a few molecules—or even of only one molecule with certain substances.

What are we going to do with these super membranes? What did we do with super-thin films?

Foams and cellular materials are rapidly becoming part of our industrial and commercial product stables. Even foamed metals are available, but they are expensive because they are difficult to produce with repeatable high quality in our one-g gravity field. Again, this is due to density differences between the liquid or melt and the gas used to produce the foam voids or bubbles. Do this in zero-g and you will have uniform distribution of the voids throughout the material, and you will not have to rush the cooling of the material to prevent the bubbles from rising. They can't rise due to density differences. Low density foams exhibit high

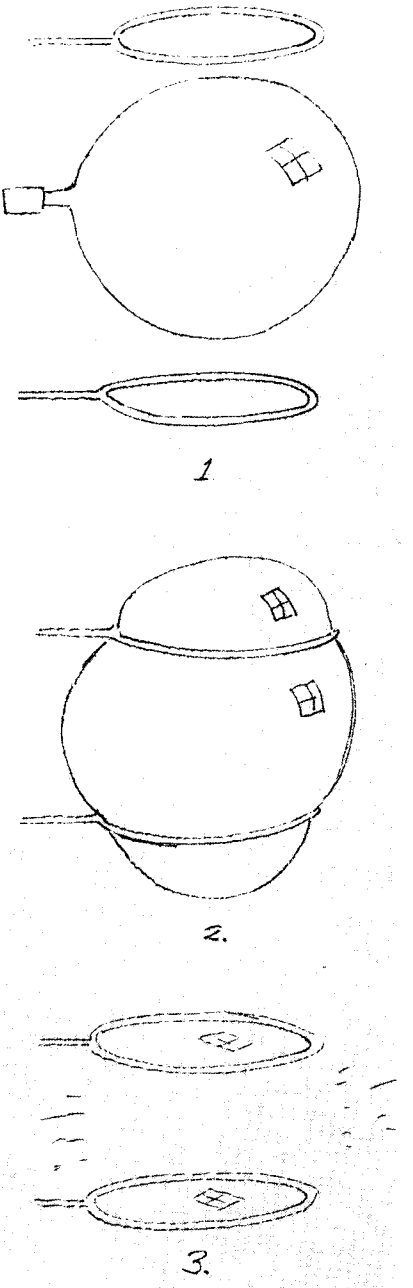

FIGURE 8. Production of very large, thin, flat membranes by the bubble process in zero-g.

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stiffness, even at high internal pressures, plastic foams have found wide use in packaging where stiffness is required. But their strength is moderate in comparison to the solid, nonfoamed material. We can improve this by making a whisker composite of the main material in zero-g before foaming it. The addition of fibers or whiskers to foamed materials will result in very strong and light materials. We will even be able to beat Mother Nature at her own game in this field, because she originally developed or evolved the fiber-reinforced cellular material called "wood" that can be cut, shaped, sawed, drilled, machined, and fastened just like a plastic. Once we have zero-g space industry making such reinforced cellular materials, we will find all sorts of uses for them, believe me.

The low temperatures and high vacuum conditions of the space environment are going to bring to maturity an entirely new area of basic chemistry: free atom chemistry. And it's *new*. During 1971, Philip Skell and J. J. Havel of Pennsylvania State University announced the results of their preliminary work in this field. Studying the behavior of molecules and what happens between them—the province of chemistry until now—does not tell you very much about the behavioral characteristics, or properties, of the atoms which make up the molecules. Common table salt is a glaring example of this. And the behavior of a single hydrogen atom is quite different from that of the bi-atomic hydrogen molecule in all of its different spin states, metastable states, et cetera. It is like trying to study an individual by studying a crowd of people . . . or studying a man and wife together in an attempt to find out what each of them could do singly.

Free atom chemistry has not been an area of great activity because of the lack of suitable techniques for experimentation. To get free atoms, one usually boils them off a hot wire in a vacuum. Therefore, the temperature of the free atoms is very high indeed. It is not possible to react these free atoms at a temperature of several thousand degrees centigrade with compounds and organic molecules that decompose at a temperature of a few hundred degrees centigrade. Skell and Havel obtained their free atoms from boiling them off hot wires in a vacuum, sending them through a vacuum without collision, and impacting them on surfaces that had been supercooled. Thus, it was possible to study reactions with low-temperature molecules because, even when the superhot free atom hit, it did not raise the temperature of the target molecule above the decomposition point.

There have been some fascinating results thus far from free atom chemistry. For example, Skell and

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Havel studied some reactions with free platinum atoms. Platinum is a "noble" metal with a high resistance to corrosion and capable of reacting only with the strongest oxidizing agents—such as *aqua regia.* This is one reason it is in demand for jewelry; the other reason is that it is damned hard to refine it because when it does form compounds, it does so with lasting friendship, so to speak.

But, using the "boil-off plus high vacuum plus supercooled target" technique they developed, they found free platinum atoms to be highly reactive. They even got platinum atoms to react with the innocuous organic molecule, propylene. Thus far, they've worked with over forty metals and discovered other unsuspected reactivities. Interactions and reactions took place on the supercooled target that had never been seen before.

Free atom chemistry holds the promise of entirely new classes of organo-metallic compounds with completely unsuspected properties. Work has only just begun, literally. It's all very experimental because the facilities are somewhat expensive. They require high vacuum and very low temperatures.

But these characteristics are an integral part of the space industrial environment!

Free radical chemistry has also been held back by much the same sort of very expensive facilities and lack of technique. Again, we do not know what we can really expect from free radical chemistry. It was surveyed over a decade ago by the U.S. Air Force Office of Scientific Research, but there were no breakthroughs. We do know that free radical chemical technology would be quite useful in rocket propulsion, for example. For over twenty years, we've known that if a method could be found to produce and stabilize monatomic hydrogen (single-H) in a liquid state, it would make a rocket propellant with very high specific impulse. It has been estimated that single-H would have a specific impulse as high as 1,200 Newton-seconds-per-kilogram, making it competitive with Nerva-type rocket engines. Letting single-H go back to double-H releases a tremendous amount of energy and gives a rocket engineer the very low molecular weight he desires for an exhaust gas. Single-H would also make an excellent energy source for earthbound uses. The space environment appears to offer the characteristics needed to study and develop free radical chemistry. It may be that in space we will develop the single-H capability to create super-cheap space transportation!

Producing these new materials with new chemistries in the space environment will certainly have the same, if not more, impact upon our culture as the development and use of plastics, semiconductors, and pe-

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trochemicals. It will require space factories to make them . . . and to make many of the other things, old and new, that we are now making on Earth with a growing problem of disposing of the wastes thus generated.

Some people will say, "Who needs them?" Others will wonder, "Why bother going into space to establish more industry? Progress isn't measured by the quality or quantity of industrial products any longer!"

Others will say nothing because they know very well that without those industrial products we are back where we were before the First Industrial Revolution when one farmer, working as hard as he could, was able to feed only one family other than his own . . . and that was at the whim of fire, flood, insect pests, and drought. True, in an agricultural peasant economy, everybody has a little of something, but nobody has very much of anything. And fifty percent of the children born die before reaching the age of five.

And still others will say nothing, knowing that the telephone wasn't wanted before it was invented. They won't talk about it; they'll go ahead and do it. Where there is money to be made and a competitive advantage to be gained in the marketplace, there will always be people ready with the risk capital, the technical know-how, and the ability to produce.

Time has a strange tendency to alter the perspective of people. A generation ago, there was a goal of getting into orbit—*period*—regardless of cost: today, getting into orbit is a commonplace thing that doesn't even make the newspapers. (How many people even noticed that Great Britain finally made it into the Space Club by orbiting their own satellite, Prospero, with their own indigenous launch vehicle, the Black Arrow, in October 1971?) Today, the major obstacle is the high cost of getting into the space environment; who is willing to bet that ten years from now cost will no longer be a problem? We will probably be worrying about having *enough* orbital capability!

We have lived thus far in a distorted part of the universe: the Earth's surface. We are moving out of this distorted, cramped, and vulnerable chunk of space into the universe where we will be able to build, fabricate, manufacture, produce, and create what we need better, cheaper, and in more quantity without further disturbing our home planet.

The Third Industrial Revolution will complete the work started by the First. It will free us forever from dependence upon our home planet and from its whims, quirks, famines, shortages, and lack of room. It will free forever human muscle power and human brain power so that we can pursue whatever our real destiny is. ■

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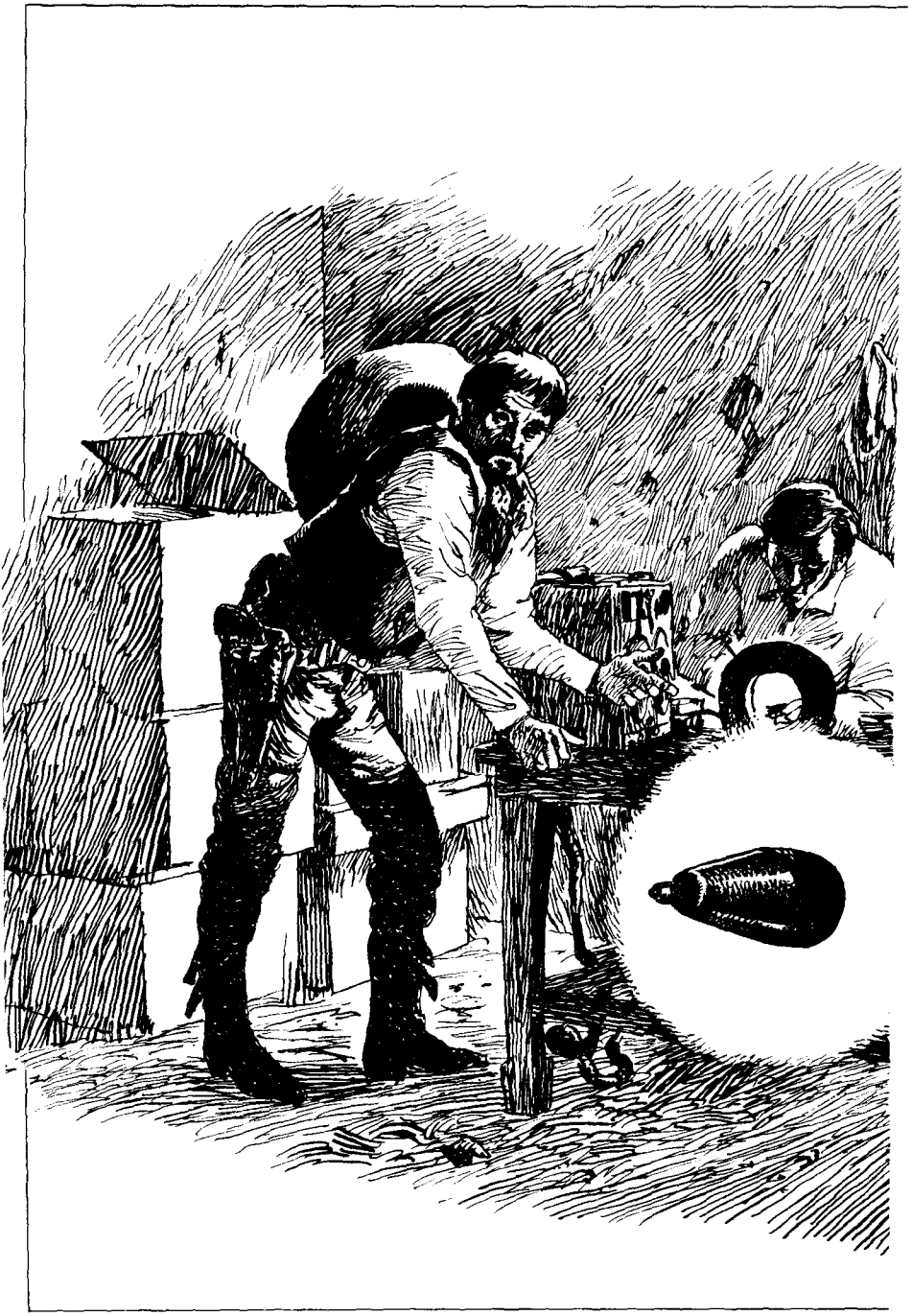

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FORCE OVER DISTANCE

The military-industrial state can sometimes amount to nothing more than two or three men with a common purpose. They don't even have to like each other . . . just have a common purpose!

TAK HALLUS

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I

"You will hurt your brain, *señor.*"

Jenson ignored him, continuing to doodle equations on the dusty tabletop, intricate and complicated equations that never converged. Several times, stymied, he moved to a fresh area of untouched dust, wiping the smudge from his fingertip before he began. Juan, Jenson's day guard, his sombrero pushed back on his head and two bandoleers crossed on his chest, peered over Jenson's shoulder, squinting through the smoke of a cigarette stub plugged between his lips. Juan reached over Jenson's shoulder, pointing at the equations.

"Why you do that?"

"What?" said Jenson, thinking Juan had noticed some error in his calculations.

"Arithmetic."

"Kicks."

"Kicks? What is kicks?" Juan withdrew his hand.

"Fun."

"You have one funny idea of fun, *señor.*"

Silently, Jenson agreed. His sabbatical year, teaching at the University of Mexico, was supposed to be fun. It had been misery. The teaching, at times, was fun. The students were eager. Yet the whole reason for the sabbatical—to shelve his research project for a year and let his mind try for a new perspective—had failed. His work dogged him like a predator, lurking behind every thought. He was so close to a solution he could almost feel it physically, an object grasped in the dark. Frequently he awoke in the middle of the night with the answer on his lips. By the time he got a pencil and paper, it was gone. Halfway through the school year, unable to abstain any longer, he sent for his equipment.

"How you know when it is finished?" asked Juan.

"The series converges."

"What you have then?"

"Zero."

"*Cero!*" Juan laughed and stood up. "You do *that* for a *cero*? You are one loco fella, *señor.*"

"Probably."

Juan returned to his guardpost in front of Jenson and near the door. An M-16 rifle leaned against a plastic packing case next to him. He picked it up and began wiping the action with a rag, muttering something about *gringos locos.* Jenson looked at his equation. Another dead end. He bounced his fist off the table, and stood up.

"Damn this thing!"

"*Cuidado!*" said Juan, suddenly alert. He gestured with the rifle for Jenson to sit down. "Do not make the quick motions, *señor.*"

Jenson remembered where he was and sat down. If only he had some paper, or better yet, a blackboard, things would go more quickly. He was running out of dust.

"*Señor*, you must not move so

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quickly. "I have the orders, you know."

"Can you get me some paper?"

"Paper?"

"So I can go on with my work."

"Paper is not in the orders."

"The hell with your —" began Jenson vigorously, but Juan leveled the rifle at him and he softened his tone. "I mean, can't you make an exception?"

"There are no exceptions. All are treated in the same way."

"How many other prisoners do you have?"

"Just you."

"If you only have one prisoner and you give him paper and pencil, you will be treating them all alike."

"*Muy logico, señor, pero* excuse me, but I have the orders and the orders say nothing of paper and pencils and you, if you will remember it yourself, have volunteered to be our guest."

Jenson remembered "volunteering." He was returning to the University of California at Berkeley from the University of Mexico, planning to stop over in Tucson and visit his sister. He was making better time than he expected, letting the turbine Porsche out to a hundred and sixty on any straight stretches of road he encountered. Between Hermosillo and Nogales, he slowed for a goat herd. A tire blew, causing him to skid onto the dusty shoulder of the road. He got out and fixed it. Only when the spare was in place did he notice the bullet hole in the old tire. He looked up from the tire. A half-dozen men in sarapes with rifles surrounded him. One of them, a short man with a tall sombrero and drooping mustachios, stepped forward.

"*Buenos dias, señor.*"

"*Buenos dias.*"

The man said something too fast for Jenson's limited Spanish. When he got no answer, he switched to English.

"It is a nice car that you have, *señor.*"

"Thanks."

"What does it cost?"

"About eight thousand, new."

"Eight thousand. That is not much."

"Dollars, not pesos."

"Ahhh," said the man, smiling and nodding to accent his understanding. An even row of white teeth showed in the middle of the mustachios, punctuated by a black gap where an incisor should have been. He snapped an order to his men. One of them opened the driver's side and got in.

"Hey!"

"Hey, yourself, *señor.*"

"What do you think you're doing?"

"Taking your car." The man waited for a reaction. When he got none, he burst into laughter, long snorting laughter that turned into a coughing spasm. After some final sputtering, he controlled himself.

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"The revolution is not good for the health."

"How am I supposed to get to Nogales?"

The man smiled, but avoided laughing.

"Walk, *señor.*"

"Walk!"

"It is good for health." He turned to his men. "*Vamonos, hombres!*"

The man in the driver's seat started the engine.

"Wait a minute."

"Wait a minute?" The leader stepped up to Jenson, bringing his face within inches of Jenson's. He grinned, his missing tooth prominently absent. "Do you know to whom you have the pleasure of addressing?"

"Genghis Khan."

The comment set off another bout of coughing, doubling the man. He repeated it to his men, who laughed, except the driver, who was practicing at the wheel of the motionless car, jerking the wheel from side to side as if working his way to the head of the pack at Le Mans. Finally the leader returned to his scrutiny of Jenson's eyes.

"No."

"Who then?"

"Who who?"

"To whom do I have the pleasure of addressing," said Jenson, annoyed enough to mimic the man.

"Me."

"Oh? And just who are you?"

"El Buitre."

"The bandit. I should have—"

"*Bandido!*" blurted El Buitre. His eyebrows went up, mock incredulity on his face. "*Bandido! No, no, señor. Politico!*"

"*Si, si,*" agreed El Buitre's men, except the driver, who was paying no attention to the conversation.

Conspiratorially, El Buitre lowered his voice, moving even closer to Jenson.

"You know what that is?"

"What?"

"El Buitre," whispered El Buitre.

"No."

"The vul-toor." El Buitre paused, stroking his mustachios before he looked up at Jenson. "It is a fear-sohm bird, the vul-toor, no?"

"Fearsome."

El Buitre threw back his head and laughed, a growling laugh with shining eyes, simultaneously loosing a quick left jab into Jenson's stomach. Jenson gasped and collapsed. Dust settled gently around him. He struggled for breath.

"*Muchachos*—" began El Buitre.

"No!" gasped Jenson.

El Buitre glared at him. "No. You tempt the fates, *señor.*"

Jenson regained some of his breath.

"You can have the car . . ."

"Of course I can have the car."

". . . but please let me keep the papers and equipment in the back seat."

"Back seat?" said El Buitre and

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peered through the back window. "What is it in the back seat?"

"My work."

"What do El Buitre care for your work? He does not. *Muchachos!*"

Jenson got to his feet. The brief case and working model in the back seat were his life work. He could duplicate it but it would take years.

"If you take my work, you'll have to take me, too."

El Buitre smiled.

They threw Jenson in a storeroom at El Buitre's camp, more a permanent village than a camp. At night, José, Juan's brother, guarded him. Only Juan knew English. The ransom, Jenson was told, would be set at fifty thousand dollars, though El Buitre was willing to bargain.

"And if you don't get it?" Jenson had asked.

"We shoot you."

II

On the third day of his captivity, Jenson's mind recovered enough to be bored. He coped with the boredom by doodling math in the dust. When he had almost exhausted the dust, the storeroom door flew open, rebounding from the corrugated iron wall with a metallic clang and narrowly missing Juan, who snapped to something like attention. El Buitre stomped in, his boots clomping on the wooden floor, and skidded a newspaper across the tabletop to Jenson, obliterating the morning's work.

"Is that you?"

"Is who me?"

"That," said El Buitre, poking at a picture on the front page of the paper with a stubby index finger. "*Este hombre ahí.*"

Jenson looked at the picture, centered on the page, nodding. It was his picture, or more accurately a ten-year-old college graduation picture.

"It's me."

"*El fisico?*"

"Yes."

"Is it true what they say?"

"You got me."

"*Correcto.* I have got you. But is it true what they say?"

"What do they say?"

El Buitre jabbed the paper. "Read him!"

Jenson started on the story under the picture, laboriously sounding out the Spanish words. Communicating with his students had been easy. They used a combination of English, Spanish, mathematics and physics. Reading a newspaper entirely in Spanish was something else again, even if he did know the subject of the article somewhat better than the reporter.

"I am waiting, *señor.*"

Jenson continued reading. After several suppositions about how he fell into El Buitre's hands—all wrong—the story went on to list his various distinctions plus a few rumors about the Nobel Prize.

"I see you upped the ante."

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"Perdone, señor?" El Buitre said.

"You're asking sixty thousand."

"One must leave room for the bargain."

Jenson finished the article. "It's correct, except for the part about you."

"It says you are working on the—how do you call it? Transmitter of the material."

"Matter transmitter."

"Sí, es verdad?"

"Yes."

El Buitre was silent, considering the idea. He stroked his mustachios. After several seconds of contemplation, he began pacing back and forth in front of the table, holding his chin and watching his path. He stopped abruptly and glanced at Jenson.

"Will it transmit the animals?"

"In theory it will transmit anything—animal, vegetable or mineral."

"Bueno!"

El Buitre paced again, his boots thudding hollowly on the floor. Jenson and Juan watched him. El Buitre paused every now and then to eye Jenson and shake his head. It occurred to Jenson that El Buitre was having pangs of conscience. If he were forced to execute Jenson, the world-renowned physicist, it would look bad for the cause, whatever the cause was. El Buitre, probably. It might also deprive the world of Jenson's potential achievements. Jenson discarded the idea, recognizing it as vanity trying to console him when nothing else was available. A more likely explanation for El Buitre's pensiveness was the ransom. With a well-known physicist in hand, rather than simply a passing tourist, the price was probably going up.

"Those things in the car, they are it, the transmitter of material?"

"A model."

"A model that works?"

"Yes."

"Show me."

Jenson gave up speculating about El Buitre's thoughts. Whatever the man was thinking, would have to appear in its own time.

"I can't."

"Why?"

"No electricity."

"You think we are *primitivos, señor físico?"* El Buitre pointed toward a socket near the base of the wall, unnoticed by Jenson. Every evening, José brought a kerosene lantern with him when he relieved Juan. Jenson had assumed there was no electricity. "What does that look like? The trap for the mouse?"

El Buitre said something to Juan, who bolted from the storeroom. After several minutes, Jenson heard an engine cough and catch. It whined a moment before it settled to a low rumble.

"You hear that, *señor*?"

Jenson nodded.

"Mi generador."

After a few more minutes, Juan

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returned with Jenson's equipment and briefcase, struggling under the awkward load of the transmitter carrying case, a three-foot plywood box with leather handles on both ends and the top.

"Careful."

Juan put the box on the table and dropped the briefcase. Jenson opened the box, examining the contents to make sure everything was there. He extracted a concrete disk a foot in diameter with a nine-inch hole in the center. Embedded in the concrete was a tantalum bar, used to focus the transmitter into a one-inch circle in the vacant center of the ring. The concrete itself was Jenson's substitute for a ground, an essential for stability. In any larger model, the focusing ring would have to be partially buried in the earth or risk an unstable field in the ring and permanent dematerialization. The ring was flat on one edge. Jenson rested the ring on the end of the table.

"What is that thing in the box?"

"A computer, among other things."

"What does it compute?"

"It's a feedback system to stabilize the field inside the ring."

El Buitre peered through the ring at Jenson. "I see no field."

"It's invisible."

"Oh."

Jenson pulled the feedback system out of the box, essentially a commercially built digital computer with a minimum of analog circuits to make decisions, modified for Jenson's purposes. Attached to the rear of the stabilizing computer was an energy converter and modulator, allowing objects passed through the ring to be converted into a stream of subnuclear particles and reassembled at the focal point. Jenson's model had only a two-foot range. He attached an inch-thick cable to a connector on the ring, then handed a line cord to Juan.

"Plug this in."

Jenson had done much of the prototype development in his apartment in Berkeley and designed the transmitter to operate on house current, though he occasionally kicked out a circuit breaker when he tried to pass large objects through the ring.

Juan stuck the plug into the socket. Jenson flipped up a safety cover on a toggle switch and activated the transmitter. The generator outside died.

"*Qué pasa?*"

"Not enough power."

"Power? We have plen-ty of power," said El Buitre, waving his arms around as if the world were filled with power, then yelled something at Juan, who rushed from the room, leaving his rifle leaning against a crate. Jenson looked at the rifle.

"Do not even think of it. I have four hundred men outside."

The generator started, this time at a higher idle.

"*Bueno. Continuáremos.*"

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Jenson activated the transmitter again. The generator kept running.

"Do you have something small I can use to demonstrate with?"

El Buitre pulled a bullet from one of the ammunition belts across his chest.

"Something nonexplosive."

"You said he would work on anything."

"In theory."

El Buitre replaced the cartridge and pulled a ball-point pen from his pants pocket.

"This?"

"Fine."

Jenson took the pen and slowly pushed it into the center of the ring. The pen barrel disappeared, as if submerging in water.

"Where he go?"

Jenson nodded toward the opposite end of the table. El Buitre's eyes enlarged.

"He sticks out here!"

The pen barrel had materialized over the table two feet from the center of the ring.

"Why does he stand in the air?"

"Because I'm holding on to it," answered Jenson, indicating the retractor end of the pen between his fingers.

"If you let go—what then?"

"It depends. If more of it's on my side, it will fall back this way. Otherwise, it will all come out where the point is."

El Buitre held both hands in front of him as if measuring a distance.

"Not fifty-fifty?" he asked.

"No."

"What if the power go off?"

"There's enough residual energy to let anything in the field get through."

Jenson pushed the pen and let go. It appeared in the air two feet away and dropped to the tabletop, clattering and rolling toward the edge. El Buitre plucked it up and examined it, scrutinizing it at close range. The generator died. Juan came back into the storeroom with a supplicating expression on his face, launching into an explanation of why the generator stopped.

"Calla!"

Juan was silent. El Buitre gazed off into a corner of the storeroom, scratching his chin. Finally he looked up.

"Bueno!"

"*Bueno,* what?"

"You want to leave here, do you not?"

"Yes."

"You may go."

"Thank you," said Jenson, standing up. He began unscrewing the connector from the ring. "I—"

"If—"

"If what?"

"If," said El Buitre, pointing at the transmitter, "you make me one of those."

"Impossible."

"Nothing is impossible."

"You can have that one." Jenson nodded toward his briefcase. "If I can have my papers."

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"Do you think I want a toy?" El Buitre held his hands wide apart. "I want a beeg one."

"How big?"

"As beeg as this room."

"You're nuts."

"Perhaps, *señor*, but that is the price of your freedom."

"We'll all be here a long time if that's the price. I've been working on the problem of how to make a large transmitter for over a year. Day and night, for a year. It simply cannot be—" Suddenly Jenson saw it: the solution he had wanted for a year.

"Pencil."

"*Que?*"

"Pencil, damn it, pencil!"

"*Lápiz y papel,*" snapped El Buitre. "*Vamos!*"

Juan riffled Jenson's briefcase, at last coming up with a mechanical pencil and blank paper. Jenson sat down at the table and pushed the transmitter to one side to make room to write. For a year he had searched for a solution, for the mathematical expression of his matter transmitter, an expression that could be extrapolated into a larger transmitter. For a year, it had eluded his every effort. He wrote rapidly, covering the sheet on both sides with mathematical expressions and phrases. Why so simple a solution had evaded him, he was unable to say. Instead of the series converging, it was infinite. As if completing a letter with a period, he bounced the pencil point off the paper and sat back.

"It can be done."

"*Bueno!* We will do it."

"But—"

"No buts."

III

The project would be difficult even in a sophisticated scientific community. In a Mexican mountain village, where women still ground corn for tortillas on large flat stones, it would be impossible. Since there were no "buts," Jenson decided to convince El Buitre by showing him. He began work on the designs.

Days passed. The pile of designs on his table in the storeroom multiplied. They let him out for an hour a day, heavily escorted by guards. On one of his walks, he noticed that the village—a collection of corrugated iron buildings and tents—was well camouflaged. There was little chance of being seen from the air.

The more Jenson got into the project, the more he enjoyed it. He could have faked the designs. No one in El Buitre's camp knew a neutrino from a burrito. The real work had to be done sometime. The present seemed ideal. No one bothered him. He was well fed. He was content to work.

Since it was impossible to actually construct the transmitter, Jenson designed with abandon, choosing the most expensive mate-

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rials and grandiose construction. El Buitre wanted a "beeg one." Jenson would design a "beeg one." To construct a transmitter with a twelve-foot projection surface, it was necessary to design a ring one hundred and forty-four feet in diameter. Sixty-four feet of it would be underground. The protruding arch would rise eighty feet in the air. With some satisfaction, Jenson wondered how El Buitre would camouflage it. He estimated the cost of the tantalum alone at half a million, dollars not pesos.

El Buitre, inspecting the designs a month later, said simply, "*Bueno.*"

"*Bueno!* Do you realize how much this will cost?"

"Make the list of your needs."

It took a day to write the matériel list. It was one of Jenson's better days. He would blithely write something on the paper, then burst into uncontrollable laughter, contorted at the idea of El Buitre trying to buy it. When he finished the list, he gave it to the bandit.

"How do you plan to get this stuff?" asked Jenson. "Sears Roebuck?"

El Buitre folded the list and tucked it into a pocket somewhere under his red sarape, then looked up, grinning as he spoke.

"Steal it."

Jenson followed El Buitre's exploits in newspapers supplied by Juan. A train was derailed near Guaymas and its reactor stolen to replace the inadequate gas engine generator. Twenty of El Buitre's men died of radiation sickness carrying the pieces back to camp. Jenson shook his head over the paper, regretting his inability to instruct El Buitre any other way.

Reports, both in the newspapers and from Juan, got worse. Without thinking, Jenson mentioned the inadequacy of the computer used with his model transmitter to stabilize a larger transmitter. The quantity of information alone would overload it before it ever got to analyzing the information. A few nights later, an analog computer system was borrowed from a factory in Chihuahua, carted over the Sierra Madre Occidental in pieces, and presented to Jenson.

"What was the cost?" asked Jenson.

"Cost?"

"In men," said Jenson. "At the factory."

"Only the graveyard shift."

When Jenson overcame his repugnance at the computer's price, he spent some of his time working out a program to match his designs. One would have to be worked out anyway. When El Buitre finally saw the impossibility of his plan, Jenson would have a copy of the program in his briefcase. Besides, working took his mind off the raids.

The government in Mexico City was panic stricken. For the first

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time since the days of Francisco Madero's entry into Mexico City, the electorate was muttering change. The conservative National Revolutionary Party was bloating its rhetoric to no avail. Speculation was giving way to fear. Why was El Buitre taking what he took? What did it mean? When four hundred banditos swept into Chihuahua and left with a computer, it was news, but news no one could interpret. There were printed rumors that El Buitre's gang was increasing. People were said to be joining just to find out what was going on.

Jenson read about small massacres. A concrete factory in Ciudad Obregon was sacked, leaving ten men dead and two cement mixers demolished. An electronics warehouse in Mazatlán was looted. Four men died. A bulldozer disappeared in Puerto Peñasco. A gas station in Topolobampo was pumped dry.

"A gas station?" said Jenson, looking up from the paper.

"We move quickly, *señor*," said Juan. "We must have gasoline. You think we use the burros?"

Reports trickled in of plundering in Guadalajara, tourists fleeing before an army of ten thousand, though El Buitre had nowhere near that many men. Zacatecas and Tehuantepec, even Merida in the Yucatan, reported raids—all disclaimed by El Buitre, who complained of shoddy journalism. He said he never got farther south than the state of Navarit.

Fall changed to winter. It snowed briefly in the mountains. A stove was installed in Jenson's storeroom. As the materials mounted, dark circles began to appear under El Buitre's eyes and his cough got worse. If the revolution demanded his health, he commented to Jenson one day after a particularly bad coughing spell, he must give it.

The bandit horde was now two thousand strong and unruly. Once El Buitre shot it out with one of his lieutenants, a man who wanted to abandon the matter transmitter altogether and concentrate on pillaging. El Buitre unhesitatingly shot the man, lamenting the necessity for it only after he checked for a pulse. El Buitre spent more and more of his time with Jenson, complaining about the problems of command. Several times Jenson tried to reason with him about the matter transmitter. El Buitre only eyed him suspiciously, evidently thinking Jenson had sold out to some faction among his men. Some of the men, especially those loyal to the dead lieutenant, thought El Buitre was mad. Why build matter transmitters, they reasoned, when there was looting to be done?

"They do not understand, Federico," said El Buitre, who had taken to calling Jenson by something like his first name. "They have no vision, no view of the future. Rob-

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bing and killing is O.K. for today, but what of tomorrow? *Mañana.* We must think of *mañana.*

"It's lonely at the top," remarked Jenson.

Sometime during the winter, Jenson began to believe El Buitre was a real revolutionary. It chilled him more than the weather. Bandits were predictable. They wanted booty. When they got it, they went home happy. You could deal with a bandit. Fanatics, on the other hand, committed to their own unalterable vision of *mañana,* were not only unpredictable but resolute. No deals deterred them. They kept their eyes fixed on a distant star while their hands cut a bloody path through any careless chunks of humanity that got in their way.

Jenson had pangs of guilt. He felt responsible for those who died, from banditos to factory workers. He had tried to show El Buitre the folly of building the transmitter. It accomplished the opposite. Matériel mounted, El Buitre's band increased, an unprecedented crime wave swept western Mexico—all due to Jenson's own mistaken notion of the best way to instruct El Buitre. He should have refused from the beginning, refused and been shot. At night he dreamed of the dead men, each sent to his doom by Jenson's folly, marching into heaven through a gigantic concrete ring.

Yet, as the days wore on and more of the matériel arrived, Jenson doubted the impossibility of building the matter transmitter. It was a small doubt at first, easily brushed aside. After all, there was still the insurmountable problem of the tantalum.

One day El Buitre, large bags under each eye and twenty pounds lighter than when they first met, walked into the storeroom and spread out a map on Jenson's work table, pointing at it.

"Do you know this place, Federico?"

"Tucson."

"The tantalum will be there Tuesday. It is being shipped from San Diego to Hous-tone."

Jenson imagined El Buitre's horde in Tucson, burning, sacking, killing. He pictured his sister in the ruins, dismembered or worse.

"Oh, no! My sister lives in Tucson."

"I will say hello if we see her. This is my plan."

El Buitre outlined a plan, a quick pincer movement into the railroad yards at Tucson. Jenson was incredulous. Bovine Mexico was one thing, but lupine America was something else.

"You'll never get away with it."

"*Por qué?*"

"Because the United States Government is not the Mexican Government."

"You are right. It is beeger." El Buitre grinned. "Like the dinosaur."

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"Remember General Pershing," Jenson said.

"Who?"

"Never mind. This plan is insane."

"They will never know what it is that has hit them."

"They didn't," said Jenson, watching the men unload tantalum from the back of a truck. It arrived with a construction engineer named Harold Wright, a man about El Buitre's size who refused to say anything to Jenson for three days, insisting on his rights as an American citizen, whatever he supposed them to be.

With the arrival of the tantalum, Jenson was convinced. The transmitter was possible. His only decision was whether to make the attempt. The men who died to collect the material, and those who died at the hands of the collectors, were dead. Refusing to go ahead would only add another name to their numbers, his own. If he refused El Buitre would certainly shoot him. If he failed, El Buitre would no doubt shoot him. Even if he succeeded, El Buitre would probably shoot him. There was little choice.

Convincing Wright to cooperate proved more difficult than convincing himself. When Wright finally believed Jenson was Jenson, the missing physicist, he was even more recalcitrant. He would sit on his stool in the corner of the storeroom muttering, "turncoat." "Benedict Arnold," "Quisling." El Buitre, Jenson tried to explain one day when he heard the bandit approaching outside, would use something more than sweet reason. The door burst open.

"How is the frog today?" said El Buitre, walking toward Jenson at the table and indicating Wright with a nod of his head.

Jenson glanced at Wright, who was sitting resolutely in the corner, staring straight ahead with a thin-lipped determination to remain silent. Wright's face, wide-mouthed with hyperthyroidal eyes, did faintly resemble a frog's.

"Very quiet," answered Jenson.

"He no talk?"

"Not to me."

"He will talk to El Buitre," said El Buitre, turning to Wright. "You will not only talk to El Buitre, *señor* engin'er, you will work for him, or your life will not be worth *that!*" El Buitre spit on the floor.

"Messy," said Jenson.

"*Que?*"

"Nothing."

Wright was silent, avoiding everyone's eyes. El Buitre walked over and planted himself squarely in front of the engineer, legs apart.

"Talk!"

He slapped Wright twice. Wright looked up, his bulbous eyes gleaming with intensity.

"Creep."

"Creep? What is that, creep?"

"You're not getting word one out of me!" said Wright. "I demand to

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see the American ambassador!"

"We have no ambassador."

"The consul."

"We have no consul."

"An attaché?"

El Buitre grabbed Wright's shirtfront, lifting him partially off the stool and staring into his eyes.

"Listen to me, gringo pig—"

"Do I have a choice?"

"No! No choice. You will work for me or I will feed your insides to the coyotes!"

Wright, his chin obscured by his distended shirtfront, seemed unimpressed. Jenson, on the other hand, was impressed, both by El Buitre's threat and Wright's defiance of it. Wright was doing what Jenson should have done from the beginning. Unfortunately, in Jenson's opinion, it was too late for defiance, noble as was the gesture. El Buitre was committed to the matter transmitter. He would stop at nothing to achieve his goal. Defiance must give way to cunning. Jenson chewed on his lip, calculating how best to use the situation. Though Jenson considered himself cunning enough in his own right, two heads were better than one. He would need Wright's help. El Buitre must be dissuaded from violence and Wright persuaded to work. Only working, would they have time to devise a plan.

El Buitre shook Wright, emphasizing his point.

"While you are still alive!"

The bandit dropped the engineer onto his stool, turning to Jenson. Defiance was incapable of achieving Jenson's long-term goal—freedom—yet it might be useful in the short run.

"*Ahora,* Federico, where are we?"

"Nowhere."

"Nowhere? How come nowhere?"

"I'm not working unless you leave Wright alone."

El Buitre's eyes narrowed. Without moving his head, his eyes flicked from Jenson to Wright and back to Jenson.

"Your insides, too, Federico, can feed the coyotes."

El Buitre drew a long Bowie knife from under his sarape. Its blade gleamed in the faint light of the storeroom. Jenson shivered.

"Engineers are a dime a dozen," persisted Jenson, noticing Wright scowl. "But physicists—"

"Twenty-five centavos a dozen," said El Buitre, thumbing the cutting edge of his knife.

"Physicists who can build matter transmitters are one of a kind—namely, me."

"You," said El Buitre, snorting. "What do I care? I had no transmitter of material before you come. I have none now. I will lose nothing. I think I cut you up for fun."

El Buitre started toward Jenson, grinning on the other side of the knife blade. Jenson was beginning to think defiance, whether for

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short- or long-run goals, was a mistake.

"Wait!" said Wright. "I'll work."

IV

They began work the next day. Jenson explained his plans and specifications to Wright, who in turn explained them to Juan, who told the men what to do. Jenson spent most of his time working on the heart of the transmitter, the energy converter and modulator. After the initial organization of the project, things went smoothly. At first he was so busy getting the various aspects of construction under way that he had no time to plan an escape. Later, he forgot about escaping altogether, losing himself in his work for days. It was work that would have to be done anyway.

Wright worked on the projection ring. Using the bulldozer and a work gang, he excavated a hole seventy feet long and seventy feet deep, a trench with sloping sides, scooped from the hillside. They leveled an area two hundred yards around the ring. Wright set up a mold for the concrete ring, building it in sections on the ground and paying scrupulous attention to detail. When the ring was complete, a half million dollars' worth of molten tantalum poured into section after section. It was as large as the foundation of a building.

One evening, shortly after the completion of the ring but before it was erected, Jenson and Wright were talking in the storeroom. Wright lounged on his cot, installed after he agreed to work. Jenson was putting the last touches on the day's entry in his step-by-step procedural journal. José, Juan's non-English-speaking brother, was reading a Spanish comic book near the door.

"What do you suppose the old buzzard is going to do with us," asked Wright, "when the transmitter's finished?"

"Shoot us, probably," answered Jenson without looking up.

"Cynic."

"Realist."

"Then why do you keep working?"

"To postpone the inevitable, I suppose."

"Nothing else?"

Jenson looked up from his notebook, laying his pen carefully in the centerfold. "What else?"

"You want to build it."

"Don't be silly."

"Who's silly? Think about it."

Jenson thought about it, resisting the idea. His only reason for building the transmitter was the threat of El Buitre's knife. That motive alone was potent enough. On several occasions he dreamed of being pursued through knee-deep snow by howling coyotes, a vulture flapping overhead. True, sometime during the weeks of construction he became convinced they could suc-

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ceed. True, the dreams stopped about the same time. But he worked because of the threat. Wright was wrong. Wright was definitely wrong. Whatever change Wright thought he noticed—if any—had nothing to do with his reason for working. It was compulsion—nothing more.

"You're working for yourself," said Wright.

"No."

"Yes. I can see it."

"I'm working for the same thing I've always worked for—our release."

"You just said, Buzz is going to shoot us."

"It was a joke."

"Some joke."

"Do you have a better explanation?"

"How long would it take you to get backers in the States?"

"I don't know," answered Jenson, uncomfortable at the implication of Wright's question. "I haven't thought about it."

"How long? Any kind of backers—government or private. A year? Two years? Five years? Your transmitter's brand new. A lot of people would have to be convinced before one speck of work was done."

"What are you getting at?"

"Here, you've got the materials. Here, you've got the manpower. And most of all, here, you've got a willing patron—"

"That's insane."

"I agree."

"You're implying that I would take advantage of all the people who died because of that . . . that . . . fanatic! I'm not responsible for that madman! Especially when he's got that Bowie knife at my throat!"

"I'm not suggesting you are."

"You're suggesting something. Whatever it is, you're wrong!"

"Am I? Here you are. You find yourself in the middle of this situation. A madman is forcing you at knife-point to do what you would have done anyway. He'll supply the material. He'll supply the manpower. You're not responsible, after all. Certainly, you're not responsible. All those people who died are already dead. Nothing will bring them back. And besides, everything you really want—want as much as El Buitre himself—is here." Wright grabbed at the air in front of him, clinching his fist. "Within your reach."

"I think we'd better end this discussion."

"Not yet," said Wright, leaning back on his cot. He propped his head up with his hands, looking at Jenson from between his elbows. "Let's talk about your patron."

"What about him?"

"We know—at least I know—why you want to build the transmitter."

"You're wrong there."

"Maybe, but why does *he* want it?"

"Why?"

"You heard me."

The question had never occurred

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to Jenson. The last ten years of his life were spent developing the transmitter. The last few months were spent building it. It seemed perfectly natural to him that everyone would want it.

"Why?" repeated Jenson. "I haven't the vaguest idea."

They erected the projection ring the next day, laying in the underground sections first. They built up from each stub of the underground "I" completing the "O" when the last keystone section was lowered into place. It occurred to Jenson, watching the process, that the Pyramids were probably built in the same way, muscle over matter. Jenson was still building the transmitter itself, yet he felt satisfaction that its most impressive feature was finished. El Buitre kept the men working after dark, painting the awesome concrete arch with camouflage paint, blotchy patches of dark and light green to blend with the sprouting grass on the leveled area around it.

After dinner, Jenson left the storeroom door open so he could look at the arch. José, forced to work all day and guard all night, was slumped against the wall by the door close to sleep. Wright was finishing his *frijoles*, noisily scooping spoonfuls from a metal pan.

"You must have *some* feeling of accomplishment, Harold," said Jenson, gazing out the open door at the painters.

Wright grunted and spooned beans.

"The size of it alone—"

"I've built bigger," said Wright through a mouthful of beans.

"What, for example?"

Wright swallowed the beans and smiled. "A mausoleum, for one."

"For who?"

"Some other megalomaniac." Wright dropped his spoon into the pan with a metallic click. "Is this thing of yours going to work?"

"I think so."

"'I think so' isn't going to be good enough for old Buzz."

"I wish you'd quit calling him Buzz," said Jenson. "It annoys me."

"You like him!" said Wright, beaming, evidently delighted at his discovery. Wright himself annoyed Jenson as much as anything else about the project. Why the man insisted on analyzing Jenson's every statement for some hidden meaning was beyond Jenson.

"No."

"You do!"

"I respect—"

"You respect *him*?" Wright laughed, a deep, derisive laugh.

"His vision."

"Wait until he cuts your guts out and feeds them to the coyotes—then tell me how much you like his vision." Wright was silent a few moments. "You realize the sooner we get this thing built, the sooner we meet the coyotes."

"Will you shut up about coyotes!"

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"It's true," Wright insisted.

"Nonsense."

"Nonsense! It's good sense!" Wright pointed out the open door. "That bandit doesn't give a taco in hell for either one of us!"

"What do you suggest?"

"Drag your feet."

Jenson was incensed. Drag his feet! When he was so close? Out of the question! Jenson controlled himself, resolving to avoid provocative conversations with Wright. He was beginning to think El Buitre was more reasonable than Wright.

"Impossible," said Jenson.

"Why?"

"He would notice."

"By 'he,' I take it you mean Buzz—Mr. Vulture."

"Yes."

"That bird wouldn't know a slowdown if he saw one."

"I wouldn't be so sure."

"It's already taken me twice as long to build that damn ring as it should have."

Jenson was startled. His temper flared. His cheeks burned. What did Wright think he was doing with this . . . this . . .

". . . sabotage!"

"Sure," said Wright. "Why not?"

"Are you insane?"

"Nope. I'm the sanest man around here."

"So say you," said Jenson, yet his feelings were mixed. There was some elusive truth to what Wright said. On the other hand, anyone who would claim to be the sanest person around, must be nuts. The man was incapable of seeing the value of the completed transmitter.

"Unless," said Wright.

"Unless what?"

"That thing really works."

"It'll work."

" 'So say you,' " quoted Wright.

"Trust me."

"Trust you!" Wright let out a sharp, monosyllabic whoop. Jenson was unable to interpret its meaning. Did Wright distrust his ability as a physicist? Or something else?

"Assume it will work. Then what?"

"We go out through it."

Jenson's antagonism melted. He smiled. He looked past Wright at the arch. Two men were finishing the last area of paint near the ground. It was perfect. He laughed, a long laugh that seemed to drain all the hostility from him. It awoke José.

"Qué pasa?"

"Nada. Nada," answered Jenson, waving his hand for their guard to go back to sleep. José slumped against the wall, closing his eyes. Jenson looked back at Wright. "What better way to leave?"

"On foot," suggested Wright. "Or by car, if they hadn't sold yours. Even a balloon would be better, if we had a balloon. But we don't have much choice."

"None at all. Only the transmitter."

They worked out a simple plan.

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Jenson was to prepare the transmitter for a test run, focusing it a few hundred yards away. The coordinant program in the computer would be set up to switch to Tucson after a half hour of operation, giving them a chance to determine if the transmitter was safe to use on living creatures.

"Two living creatures," said Wright making a "V" with his fingers. "When we're sure it's safe, we tell Buzz another test jump has to be made, and—poof! We're gone. It's simple."

Jenson shook his head in admiration. The most obvious solution to their situation had evaded him. It was the same problem he had with the original mathematics of the enlarged transmitter, the forest and the trees.

"Harold," said Jenson, reflecting on the plan, "You're brilliant."

"*De nada,*" said Wright, finishing his beans.

A control shed had been built to house the equipment. The power supply gave Jenson the most trouble. Though he was a physicist, he had little experience with fusion reactors. It took him several days just to figure out a method of reassembling it without overexposing the workmen to radiation. Doubts nagged him. When he started working on the Tucson program, the doubts got worse. Something was bothering him. It was difficult to pinpoint. Occasionally he found himself staring off across the hills, wondering what was troubling him. His brain told him the transmitter was finished. His intuition told him it needed work.

Jenson rechecked all the equipment, matching everything against his calculations. Everything was perfect. His malaise continued. The more he thought about it, the less he trusted his creation. He rechecked the calculations themselves. They were accurate to six decimal places. He could find nothing wrong, yet the feeling that something was out of control persisted.

His cheerfulness gave way to depression. He continued to work, rechecking what had already been rechecked. Grumpy, curt, he snapped at everyone except El Buitre, though he felt like snapping at him, too. Finally, one night when El Buitre stopped by the storeroom for a progress report, Jenson drew a line across the bottom of the last filled page in his notebook.

"Finished," said Jenson, flipping the pen onto the table.

"*Bueno,*" said El Buitre, his tone more of long-expected satisfaction than enthusiasm. "We will make him work tomorrow."

"Who?"

"*Su aro mágico.*"

"It's not magic."

"It better be," interjected Wright.

"*Sí.* He had better be," agreed El Buitre, picking up Jenson's notebook and weighing it in his hand.

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"I think I keep this notebook."

"Hey!"

"Hey, who?"

"Those are my notes!"

"*Si.*"

"How am I supposed to operate the transmitter without notes?"

El Buitre tapped his temple with his free hand. "Use the head. This is the insurance." He snapped the notebook closed, tucking it under his sarape. "If the book stays, the *fisico* stays."

"But–"

"No buts!" El Buitre grinned, his missing tooth accenting the grin's ferocity, and left. They could hear him say "Watch them closely" in Spanish to someone outside. José entered and immediately fell asleep against the wall.

"Old Buzz is a real cagey bird, isn't he?" said Wright.

"Shut up!"

Jenson was bewildered. His notebook, his most important possession in the village–or anywhere, for that matter–was supposed to go with him through the transmitter. Agitated, he looked around the room. If only he had made a copy! His eyes fell on Wright.

"We can't go now."

"Why?"

"Why! Isn't it obvious?"

"No."

Jenson pointed toward the door. "*He's* got my notebook!"

"So?"

"So we can't go! It's my lifework!"

"Take your pick, your life or your work."

"Very glib, but it's not *your* lifework!"

"You're right. Just my life." Wright was sitting on the edge of his cot with his hands clasped between his knees. He leaned forward, scrutinizing Jenson's face. "Are we going?"

"I said no."

"That's what you said, all right. Are we going? It'll probably be our only chance."

"That doesn't matter."

"What matters?"

"I don't know," said Jenson, avoiding Wright's gaze.

"Does your life matter?"

"I don't know. Yes, it matters. Stop it!"

"Your work?"

"Stop it! Why are you doing this?"

"My life matters, too," said Wright. "At least to me. And it's in your hands. I have to be able to trust you."

Jenson looked at Wright. The man was unsure whether to trust him. The idea was incredible. Jenson wanted to escape as much as Wright. He also wanted to give his work to the world. He had set his goal years before. It was only now near success. Jenson remembered the years of work, fixing his attention on this distant goal. He remembered the years of sacrifice. Give it up? Leave without the

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notebook." The years would mean nothing. He would mean nothing. "You can trust me."

"We'll see," said Wright. "Tomorrow."

V

"Snake."

"Where?" said Jenson.

Jenson and Wright were standing on the mesa twenty feet from the arch. It towered above them, immense and triumphal. Jenson hugged himself, trying to keep out the morning cold. El Buitre was forming his men into a wide semicircle around the arch, some in red sarapes and others in *campesino* blouses and wool vests. Even two thousand men looked minuscule compared to the arch. Jenson had ticked off the last item on his checklist and activated the transmitter five minutes earlier. The reactor, capable of powering a small city, barely noticed the load. They had left the control shed and walked to the arch. Jenson squinted at the center of the arch. He could make out a faint, shimmering line, describing a twelve-foot circle in the air at the center of the arch, but no snake.

"I don't see it."

Wright swept his arm through the air, tracing the line of the arch. "All that camouflage paint makes it look like a snake."

Jenson grunted. It still looked triumphal to him. El Buitre yelled several times, quieting his men. He walked over to Jenson.

"Where he come out?"

"Who?"

"What we put in."

"Oh, over there." Jenson pointed across the open area to a hill three hundred yards away, a hill touched with white by the first spring wild flowers. El Buitre glanced around and waved a squad of men toward the hill. They trotted across the mesa, momentarily disappearing over its edge only to reappear climbing through the flowers. Halfway up the hill, they stopped.

"There?"

"About."

El Buitre waved again and turned to Jenson. "We begin."

Jenson looked around for something to feed through the transmitter. Anything would do. His eyes stopped at El Buitre.

"Your hat."

"*Mi sombrero?*" said El Buitre, glancing up at its brim.

"Let me borrow it."

"Oh, no!"

"For science."

After some thought, El Buitre loosened the chin cord and pulled off the sombrero, grumbling about how El Buitre cared nothing for science. He handed it to Jenson. Before he let go, he squinted at Jenson. "Your machine, he had better work, *hombre*."

"It'll work," said Jenson, imagining his own rigid body, riddled with bullet holes, being fed through

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the transmitter like a log through a pulverizer.

El Buitre snorted, letting go of the sombrero. Jenson walked to the bull's-eye of the arch. The sound of low conversations and shuffling feet died when he stopped. They were watching him, waiting. He grasped the sombrero by its edge, testing it against the wind with a slight flick of his wrist. He hesitated, suddenly convinced the transmitter needed more work.

"What's wrong!" yelled Wright.

"I–nothing!" yelled Jenson, adding softly to himself, "probably."

"Well, throw the damn thing!"

Jenson threw it. The sombrero glided, spun, started to pitch, and vanished. A shout went up from the squad on the hill. They scrambled a few feet down the hillside and stooped. When they stood up, one of them waved a sombrero back and forth over his head, setting off cries of *"Olé"* and applause from the men around the arch. Jenson's doubts gave way to affection.

"You work."

It was the most incredible thing Jenson had ever seen in his life. He looked back at El Buitre and Wright.

"Hey!"

They ignored him, watching the man with the sombrero detach himself from the squad and run toward them, knee-deep in flowers.

"Hey, you guys! It works!"

The man with the sombrero sank below the edge of the mesa, then reappeared in stages, his head, waist, and finally his boots, running toward El Buitre. He stopped panting in front of El Buitre, who snapped the sombrero out of his hand and scrutinized it minutely. Jenson looked back at the arch, following its curve with his eyes.

"I can't leave you now."

"Bueno," said El Buitre behind him. "Federico!"

Reluctantly Jenson turned his attention to El Buitre, walking over to him.

"It works."

"Sí."

Jenson was still dazed. "I can't believe it. It works."

"Sí. We must try something beeger."

"Yes, bigger. It works."

"We got the message," interjected Wright.

"Un animal," said El Buitre.

When the idea registered, it pulled Jenson from his daze. An animal. It was too early for animals. There were tests, alteration, perfections to be done. What if they were successful? Wright would force him to go to Tucson. Tucson was out of the question. This was no time for a vacation. He must work, modify, perfect.

"It's too early for animals."

Wright scowled. Jenson avoided his eyes.

"Why?" said both Wright and El Buitre.

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tests. We have to make tests. It has to be per—safe."

Quien no se aventura," said El Buitre, "*no ha ventura.*"

"This isn't the time for adventure."

El Buitre narrowed his eyes, pushing his face in front of Jenson's. "You want to keep El Buitre happy, do you not?"

"Yes, but—"

"No buts. We do the animal."

Jenson gave up. If they failed, only a goat or dog or cat would be lost. If they succeeded—he could think of something.

"What kind of animal."

El Buitre grinned, his face still inches from Jenson's. "*Una rana.*"

It took Jenson several seconds to remember that *rana* meant frog. Two men grabbed Wright.

"Hey!"

They dragged Wright, struggling between them, toward the projection surface.

"*Pare*—" shouted Jenson, confused. The men stopped, looking back. Wright continued to struggle. Jenson needed time to think.

"Why you stop them?"

"Why—ah . . . I," said Jenson, then saw a possible out. "An inanimate object like a hat is one thing, but a man—"

"*Una rana,*" corrected El Buitre, grinning.

"A man is something else."

"What?"

"Alive."

El Buitre grunted.

"The transmitter has to be perfectly stable. Let it warm up a few more minutes."

It was difficult to tell whether El Buitre believed him. Since the transmitter was entirely solid state, it was as "warm" as it would get. Jenson could do nothing to prevent Wright's being fed into the transmitter. His only hope was to convince El Buitre to postpone the test for ten minutes, allowing the coordinate program in the computer to shift to Tucson. Wright would have a chance—if slim—of escape. When Wright failed to materialize on the hillside, Jenson could say it proved his point. The transmitter needed more work to project life. El Buitre would never know the difference. Wright, one way or the other, would be in Tucson.

"How long?"

"Fifteen, twenty minutes," answered Jenson, leaving room to bargain.

The bandit's eyes narrowed, his expression taking on a vicious look. Jenson shivered.

"Pepe!" shouted El Buitre.

José, their night guard and Juan's brother, broke from the men around the arch and ran up to El Buitre.

"*Si, mi generalisimo.*"

"Talk to Federico about the little . . . *viaje.*"

José looked puzzled.

"José doesn't speak—" began

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Jenson, but El Buitre's expression cut him off. José's face, round and somewhat more intelligent-looking than his brother's, lit up. He looked at Jenson.

"How's the weather in Tucson, Fred."

Somewhere in the back of Jenson's mind, a coyote howled. El Buitre flapped the back of his hand toward Wright's guards, a scooting motion, telling them to proceed. *"Vamos, muchachos!"*

They pushed Wright to within a few feet of the projection surface. He looked back at Jenson, his face plaintive. Before Jenson could say anything reassuring, they shoved Wright under the arch, jumping back at the last second. Wright disappeared.

"Hop," said El Buitre.

A cheer went up from the hillside, followed by another "Olé" from El Buitre's men. A figure was tumbling through the wild flowers below the squad.

"Turncoat."

"Harold."

"Benedict Arnold."

"Harold!"

"Quisling."

"Is it *my* fault if *he,"* said Jenson, lingering on the word and hooking his thumb at José, who was sitting on a packing case, his legs dangling toward the floor of the storeroom, polishing a rifle in his lap, "speaks English?"

Wright, relaxing on his cot with one leg up and his hands behind his head, grunted, staring at the ceiling. A mariache band was playing outside. Shouts and occasional thuds against the corrugated walls of the storeroom kept them awake. El Buitre had ordered a fiesta—*fiesta del aro mágico*—to celebrate the success of the matter transmitter. The fiesta was two hours old.

"How was *I* supposed to know?" continued Jenson, reacting to Wright's accusatory silence. "He was a sleeper, a linguist in bandit's clothing, a charlatan! You can't hold me responsible! It was him!"

"He," corrected José. "I was just doing my job."

"Who asked you?"

"No one."

"Where did you learn English, anyway?"

"I learned some of it from you."

"Me!" said Jenson, momentarily forgetting Wright in the face of this new accusation.

"At Berkeley."

"*You* were one of my students?"

"Yep."

"I don't remember you."

"There were five hundred freshmen in the class."

Wright snorted. Jenson glared at him.

"That still doesn't mean I taught him English."

"*I* didn't say anything," said Wright. "You want another surprise."

"No."

"Ask him what he majored in."

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"What does that have to do with anything?"

"Just a hunch. Ask him."

"All right," said Jenson, turning to José. "What did you major in?"

"Physics."

Jenson felt a cold chill. With the transmitter complete, anyone could operate it. A physics major was more than qualified. They would still need Jenson to make repairs.

"B.A.?" asked Jenson, hopefully.

"Masters."

Jenson, suddenly expendable, cleared his throat. Wright interrupted before he could continue.

"I wasn't talking about José, anyway. I was talking about you, you and that lame excuse about it being too early for animals."

"It was."

"You didn't think so when you set the program for Tucson."

"That was different."

"How?"

"It just was," answered Jenson, annoyed. Wright was starting his amateur psychoanalysis again. It served no purpose. Jenson concerned himself with reality and the outside world. So fleeting a phenomenon as human motives--especially his own--had little place in it. He had his work. He did it. What else was there?

"I'll tell you what the difference is."

"Please don't."

"It worked."

Jenson controlled himself. Wright was treading on thin ice.

"It worked and you couldn't leave it."

"You're wrong there. If it hadn't been for this . . . spy, you, at least, would be in Tucson."

"Chance."

"What?"

"You made up your mind when there was no other alternative."

"He's right," said José.

"Who asked you?" shouted Jenson. "Who the hell asked you anything at all? What are *you* doing here anyway? A man with your background, working for that . . . that . . ."

"Lunatic," supplied Wright.

"He's not a lunatic," said José, quietly. "He's a visionary."

Wright whooped and sat up on the cot.

"He is!" insisted José.

"I'm surrounded by lunatics," said Wright. "Buzz, Jenson and now, *you!*"

"I frankly don't give a damn what you think," said José. "Mexico needs him."

"And I need a hole in the head."

"You may get one," said José, polishing his rifle.

Jenson balked. The conversation was going sour. Wright, undeterred, swung his legs around and sat on the edge of the cot.

"How can you justify carving his vision out of human flesh, most of it Mexican flesh?"

"Necessity."

"I hear the echo . . ."

"I don't," said Jenson, looking

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around. All Jenson heard was the mariache band.

". . . of history. Every butcher for two thousand years has justified murder, rape and every atrocity under the sun by running up the flag of 'necessity.' Richard the Lionhearted once cut the intestines out of every Moslem he could find in Jerusalem and strung them end to end in the streets. It was 'necessary' to get at the gold they were supposed to have swallowed, and The Cause needed gold."

"Did he get it?"

"No."

"Some guys have hard luck," said José.

"What about your own life?" said Wright. "Since you don't seem to care about anyone else's."

"Me?"

"What if you get killed?"

"I don't matter."

"Fanatics!" said Wright, disgust encrusting the word. "They're all alike."

The door next to José burst open, splashing the last of the day's sunlight on the wooden floor. El Buitre, his sombrero dangling down his shirt front, swayed in the doorway, a thin-necked wine bottle in his left hand. He grinned, shoving the sombrero over his shoulder with his free hand.

"Señores," said El Buitre and staggered forward. Cool air followed him into the storeroom. "It is so nice that you have come to my fiesta. *Muy buenas noches."* He bowed deeply at the waist, passing the wine bottle under his stomach. The sombrero slipped from his back and dangled toward the floor.

"How's it going, Buzz," said Wright.

"Buzz? What is that buzz?" said El Buitre. "The buzz saw, buzzzzzzzzzz."

Jenson shivered. Drunk, El Buitre was more unpredictable than usual. Wright was pushing him too far, especially since Jenson was now expendable.

El Buitre, the wine bottle still in his hand, flapped his arms, sloshing wine out of the bottle. "I am no buzz saw." He walked around in a circle, flapping his arms. "I am the vool-ture, the fear-some vool-ture!" He stopped in front of Wright. "What is this buzz?"

"Buzzard," said José. "It's a kind of vulture."

El Buitre glanced around at José, snarling. "Who ask you?"

"Sorry."

The bandit gave José a lingering stare before he turned back to Wright. "Now, what is this buzz?"

Wright nodded toward José. "Like he said, it's for buzzard. It's an affectionate name for a vulture."

"Affectionate? The gringos like the vultures so much?"

"Some do," said Wright, glancing at Jenson.

José burst out laughing.

"Calle la boca, hombre!" yelled El Buitre, lowering his arms.

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Jose was silent. Jenson was terrified.

"Do you like the vool-tures, engin'er?"

"I can take them or leave them."

El Buitre belched and swayed, looking around the storeroom. He stroked his mustachios, thinking. He looked at Jenson, his expression pensive, then returned to Wright.

"What one is the most fear-some to the gringo ear?" asked El Buitre, pulling on his earlobe. "Vool-ture or buzz?"

"Buzz, I think. Vulture sounds too Latin."

"You joke?"

"No," answered Wright. Jenson cringed.

"You just say that buzz was affectionate."

"It's fearsome, too."

El Buitre looked directly at Jenson. "You agree, Federico?" Jenson, unable to speak, much less disagree, nodded up and down. The bandit raised his wine bottle to his lips. Wine gurgled from the bottle. He lifted it higher and higher, his chin extended and his Adam's apple working. Wine trickled from the corners of his mouth, running down his brown neck. When the bottle was empty, he threw it over his shoulder. It shattered on a packing case near Jose. He glowered, the expression Jenson had dreaded, and began working at the flap on his holster, loosing its obstinacy. Finally, after starting over several times, he got the holster open and extracted his .45. He fired into the recesses of the storeroom, shrieking "El Buzz!" and squeezing off round after round. In the small storeroom, the explosions were deafening. Lead ripped through sheet metal and ricocheted around packing crates, occasionally thudding into them. Someone outside screamed. El Buitre kept firing. Jenson got down on his hands and knees, crawling under the table. He could see El Buitre's boots walking in a circle, hear his screeches, and feel his teeth vibrate with every round. Suddenly the firing stopped. El Buitre peered under the table.

"Federico?"

"No!" said Jenson, remembering he was expendable.

"What you do there?"

"No!"

"No, what?"

Jenson looked up at the bandit, still covering his ears with his hands. "No, please?"

"No, no. I mean why you say 'no'?"

"Don't shoot."

"I am out of bullets."

"Don't reload."

"Federico—"

"Don't—"

"Federico."

"What?"

"Tomorrow set the transmitter for *Ciudad de Mexico.*"

"Mexico City?" said Jenson, re-

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moving his hands from his ears. There would be a tomorrow.

"*Si,*" said El Buitre quietly. "El Buzz is going to visit *la capital!*" The bandit glanced at his .45. Jenson looked at it, too, noting that the muzzle seemed four times the size of the rest of the gun. The action was still closed. "I still have the bullet."

"No," said Jenson.

El Buitre stood up, fired through the ceiling, and left, slamming the door behind him.

Jenson crawled out from under the table. The air smelled of cordite. He was thankful it smelled at all. Wright and José were still on the cot and the crate. Wright, looking at José, nodded toward the door.

"Some visionary."

José was silent.

VI

When Jenson recovered from what he still considered his brush with death, he and Wright were separated to prevent any escape plan. Jenson got the storeroom. Wright got a tent with three guards. Jenson was content to be alone. The day had exhausted him. The pinnacle of success followed by a glance into the abyss—it was too much for one day. Anyway, the Freud of the Sierra Madre was annoying—even dangerous—to have around. He antagonized the wrong people, El Buitre among them.

"When you're through with those Mexico City calculations," said José, stoic on his packing case, "I'm supposed to look them over."

"Doesn't *anyone* trust me?"

"El Buitre just doesn't want any Tucson detours."

Jenson moved from the table to his cot, propping his head up with a pillow. It was his first opportunity to reflect on the transmitter's success.

"José," said Jenson, looking at the ceiling. "Do you realize what this is going to mean?"

"What?"

"What we're doing here. It's a revolution."

"That's the general idea."

"In the next fifty years—no, twenty years," continued Jenson, noticing a star through the hole in the ceiling, "the world can be a garden. It's possible to take one continent—say Australia—and set it aside for industry. The rest of the world can be a playground. Anyone who works in Australia can live anywhere he wants, step through an arch like ours in the morning and step back home at night."

"What about the Australians?"

"All right, we'll use the Sahara Desert, or even better, the Moon." Jenson imagined the Moon, covered with industry and arches. "It will be the greatest single uniting force in the history of man."

"Could be."

"*Could* be." said Jenson, warm-

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ing to his subject. "It *will* be. A rational, worldwide civilization is within our reach."

"Men aren't always rational."

"You sound like Wright."

"Dynamite, if you remember, was supposed to make war impossible. Nuclear energy can power a city or flatten it."

"So?"

"So the question's never what's invented, but how it's used. And as far as worldwide civilization, there's that old stumbling block, sovereignty. Nations will never relinquish their precious sovereignty." Jose paused, thinking over what he had just said, then added, "voluntarily."

"Politics."

"That's right."

Jenson never particularly cared for politics. Democrats or Republicans, revolutionaries or reactionaries, they were all the same to him. International politics was even more childish, armed squabbles over ephemeral values. Physics was more reliable. Political caprice could never replace the reality of physics. He trusted physics. It would always be there.

"Politics is none of my business."

"Indifference is a political position."

"So they say," said Jenson, deciding to change the subject. "Incidentally, why does El Buitre want to go to Mexico City?"

"You aren't *that* naive," said Jose, laughing. He nodded toward the rifle lying across his lap.

"I thought—" began Jenson, but his imagination brought him up short. He imagined two thousand men materializing in Mexico City, sweeping everything before them. He imagined the horde swelling, becoming a national army, an international army. If El Buitre could take Mexico City, he could take Washington, London, Paris, Moscow, Peking, or Lubumbashi! Everything and everyone were potentially within his reach. It was staggering! Nothing was safe! Governments, centuries-old institutions, civilization itself could fall before El Buitre's horde, riding out of nowhere and seizing everything!

"You thought what?"

"I thought the killing was over."

That night Jenson dreamed of raids, dreams tinged in the red of fire and blood. Moscow, Rome, Atlanta—all burned again in his dreams. Congress, Parliament and the Kremlin exploded under cannon shot, fired into the matter transmitter in Mexico. The faces of screaming women and children swam through his mind, flailing their arms. Miles of refugees, hopelessly trying to escape the inescapable, tramped through his brain. Barbarism raged from ear to ear. In the night sky of his mind, constellations rearranged themselves, spelling out "MEXICO NEEDS HIM!" "MEXICO" was crossed out and "THE WORLD" added. Jenson

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himself, a figure naked in driving rain, fled four horsemen, their horses snorting fire. Hooves, clapping thunder, trampled him under foot, yet miraculously he survived to find himself roasting on a spit with an apple in his mouth, turning faster and faster, El Buitre's laughing face flashing past with each revolution of the spit. He awoke in a cold sweat.

The storeroom was silent. José, visible in the dim light only as a rifle across a lap, watched him.

"What time is it?"

"Four."

"I was dreaming."

"I figured."

"Horrible things."

José was silent.

"Get me a light."

Jenson blinked against the flaring match. José, tilting back the lantern chimney, lit the mantle. Hissing, the lantern caught, flooding the center of the room with a shivering circle of light. Jenson got out of bed and dressed. Sleep, with the four horsemen waiting, was impossible. He started on the Mexico City program.

The more Jenson worked, the more he felt driven to work. When he paused for a moment to mull over some calculation, his dreams impinged, as vivid in his mind as an event in life. Jenson had always trusted his unconscious mind. It solved problems for him. When he was stymied in his research work, he would pack his mind full of data and turn his attention to something else. Usually the answer would come to him, full-blown and correct. The same thing was happening now. He could feel something within himself, forcing its way to the surface. He continued working.

By mid-morning, after Juan relieved José, he was almost finished, yet the memory of his dreams and their unsettling feeling continued. He was working on the altitude parameter of the coordinate program. He glanced over the calculations, automatically rechecking the figures. There was an error, the first he had noticed that morning. Mexico City, according to the detailed maps supplied by José, was 7,348 feet above sea level. It was 1,182.5168 miles from the projection surface to the point where El Buitre wanted to materialize. At that distance, an error of .00015 percent in his calculations meant an error of 30 feet in Mexico City.

"Thirty feet," said Jenson. He stared into one corner of the storeroom, reflecting on the error. For the first time that morning, he felt relaxed. No dreams impinged.

"*Perdone, Señor Jenson?*"

"Nothing, Juan. Just a thought."

Jenson finished the program at noon.

At four o'clock, José came to check the figures. Jenson hovered behind him, peering over his shoulder and explaining anything difficult.

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"What's this?" asked José, pointing at a series of equations and their equivalents in real numbers. Jenson tensed.

"What?"

"This. What's seven and four?"

"Eleven."

"You're sure about that."

"Yes. Why?"

"You've got twelve here."

"Oh," said Jenson, relaxing. Mathematics was Jenson's forte, not arithmetic. He quickly corrected the arithmetic. José finished his checking and tapped his pencil point on the table.

"No detours at least."

"What does that mean?"

"I'm not sure," said José. "Somehow it just doesn't feel right."

"That's you, not the program," said Jenson. "Remember, it's been a few years since you did this kind of work."

"I suppose so."

José gathered the papers and stuffed them into Jenson's briefcase, snapping it shut.

"That's that," said José, standing up.

"Where are you going?"

"Out. You'll be alone tonight, but don't get any ideas. You'd never make it."

José left, locking the storeroom door behind him. Jenson looked at the closed door, imagining escape followed by his body in a shallow grave, a hand protruding through the loose soil like a lily. He lay down on his cot, planning to think things through. Instead, he fell into a deep sleep, uninterrupted by dreams.

Somewhere in the distance a bird screeched. Jenson listened. Another screeched. He opened his eyes. Something scraped and banged on the corrugated iron of the door. A nail, being drawn from wood, squeaked. The bird image faded. Jenson sat up. After a loud *twang*, the storeroom door came open.

"Come on."

It was Wright.

"But—"

"No buts."

Wright's clothes were ripped and an ugly-looking gash trickled blood down his forehead. Whatever means Wright used to escape, the ferocity of the encounter had left evidence.

"How—"

"No hows either," said Wright, leveling an M-16 at Jenson. "They're all down by the transmitter. We've got about ten minutes before the two women I jumped recover."

"Women?" said Jenson. "Women did that?"

"Everyone else is getting ready for the raid."

"But the computer isn't—" began Jenson, then broke off, remembering José. "Where are we going?"

"Just follow me."

They left the storeroom. Jenson, crouching, followed Wright around the corner of the building. It took

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Jenson several minutes to realize they were making a wide circle around the camp. He pulled Wright's tattered sleeve.

"We're going the wrong way," whispered Jenson, pointing back the way they had come.

"Get down," said Wright, dropping into the tall grass on the hillside. Jenson looked around. He could make out the tips of several red sombreros, bobbing up and down near the crest of the hill. He got down next to Wright.

"Where are we?"

"In the gully below the transmitter."

"Are you nuts?" whispered Jenson. "One sight of us and we're both dead. We're expendable nowadays, you know."

"I know."

"So let's get out of here."

Jenson started to squirm around in the grass, preparing to retrace their path. Wright grabbed his elbow.

"This is the only way. If we try to make it on foot, they'll just send men after us. We have to get as far from here as possible and as fast as possible. In the confusion at the other end—"

"The other end. You're not going through the transmitter."

"As a matter of fact, *we're* going through the transmitter."

"Oh, no."

"Oh, yes."

"We can't."

"Listen, Jenson, I've had about enough of you. You may not want to leave your creation up there, but I sure as hell do. And you—whether you like it or not—are coming with me. You're a national resource."

"You've got me all wrong—"

"I've got you dead right. Now keep quiet."

Wright brought the muzzle of the rifle to bear close to Jenson's face.

"You wouldn't shoot a national resource."

"Only if it's a choice between it and me. Now, shut up."

Though Jenson was pleased to see the sanest man around close to irrationality, he was silently pleased. Wright, for some reason entirely beyond Jenson, was determined to beat El Buitre to the transmitter. Resistance, at this point, would be futile.

"Why don't you go after they do?"

"It may shut off."

"It won't," whispered Jenson. "I know that equipment backwards and forwards."

"Do you know it since José's been working on it?"

"No."

Wright started to crawl around the base of the hill. Jenson followed. They arrived at a point Jenson estimated was beside the arch, and started toward the crest.

From over the hill, Jenson heard El Buitre's voice.

"Muchachos!"

There was a mechanical sputter.

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An engine caught and shrieked, the high shriek of a two-stroke engine. Jenson, crawling with a frog-leg movement, worked his way to the crest of the hill next to Wright, peering over. He could see the edge of the arch. It looked more like a camouflaged monument from their angle. A wooden ramp had been set up in front of the arch. Jenson looked at El Buitre's men.

"Somehow," whispered Jenson. "I pictured horses."

"Not Buzz. He's mechanized."

Row after row of El Buitre's men, three abreast, each dressed in bright red sarapes and sombreros with rifles slung across their backs, were kick-starting red Hondas. Suddenly, other engines caught. An earsplitting roar blasted across the mesa. Exhaust billowed in a gray cloud over the men astride their machines. The line of men on motorcycles stretched over the other edge of the mesa and out of sight, a Chinese dragon of men and machines. El Buitre, the dragon's head, twisted the accelerator of his Honda, the only white motorcycle in the pack. It was inaudible in the din of engines. He waved his arm in a sweeping "Follow me" motion.

"Now!" yelled Wright, jumping up and sprinting toward the arch with his rifle in both hands.

"No!" shouted Jenson. His cry was drowned in the noise of engines. Jenson scrambled onto the mesa after Wright. Legs and arms pumping, he pursued. Wright was

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fast, but short. The rifle, throwing him slightly off balance, slowed Wright. Jenson gained on him.

In the corner of his eye, Jenson could see El Buitre. The bandit saw them and grinned. The white Honda hopped, a momentary wheelstand before it settled to the dirt. El Buitre, hunched over the handlebars, elbows up, was heading straight for them, his mustachios pressed against his cheeks. Momentarily, superimposed on El Buitre and the first rank of riders, Jenson saw four horsemen. He dove for Wright's heels, felt contact and grabbed the ankles. They fell, skidding to a stop ten feet from the ramp.

An instant after the fall, El Buitre's front wheel hit the ramp, its spokes invisible with motion. His white Honda hopped and he melted into the bull's eye. Red sarapes flapping, the first rank of riders hit the ramp. Jenson and Wright were enveloped in dust and noise. Only the noise and dust and his grip on Wright's ankles were reality, produced by rank after rank of riders taking the ramp. The world was dust and noise. Jenson could hardly breathe. He lay prostrate, his cheek to the ground and arms extended, struggling to stay conscious and hang on to Wright.

Finally, when Jenson was near blacking out, the noise diminished, then faded rapidly. He heard a last thud on the ramp, the roar of engines when the rear wheels are freed from traction, and silence, complete and total. After a few moments, his ears began to ring. He opened his eyes. The dust thinned, broke in patches, then blew away entirely. Jenson inhaled deeply, tasting the dirt in his mouth. Wright, prone in front of him, was covered from head to toe with an even coat of powdered dust. Wright looked back along his body, moving his lips.

"What?" yelled Jenson, still deaf from the vanished motorcycles.

Wright moved a dusty object around, pointing it at Jenson. After several seconds, Jenson recognized it as the M-16. Wright mouthed the words "Let go."

Jenson let go. They stood up. Jenson's ears began to clear. He spat once, turning the dust on his lips to mud. He began slapping his clothes, raising a small dust cloud around himself.

Wright leveled the rifle at Jenson.

"After you."

Jenson stopped slapping himself. "Listen to me."

"Let's go, Jenson."

Wright swung the muzzle of the rifle toward the arch, indicating Jenson was to go first.

"Please! Listen!"

"What is it?"

"I made a mistake."

"Mistake?"

"In the program."

"What kind of mistake."

"If I'm right, they just materi-

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alized thirty feet off the ground."

"Thirty—" said Wright, his expression, under the dirt, stunned. "When did you figure this out?"

"Yesterday. I left it in the program."

Slowly, Wright lowered the rifle. A broad grin surfaced on his face. His teeth were mottled with dirt. "But that's sabotage, Fred."

"Why not," said Jenson. "We can get a truck at the village."

They started toward the village. At the edge of the mesa, Wright stopped, looking at Jenson. Except for Wright's eyes, glistening through the dirt, his face looked mummified.

"I think I owe you an apology."

"What for?" asked Jenson.

"I thought—" Wright shook his head from side to side, finding either the apology or the reason it was necessary difficult to express.

"You thought what?"

"I thought you were as much a fanatic as the rest of them."

"Forget it," said Jenson, glancing back at the arch. It was a lifeless structure of concrete and metal, nothing more. "I almost was a fanatic." ■

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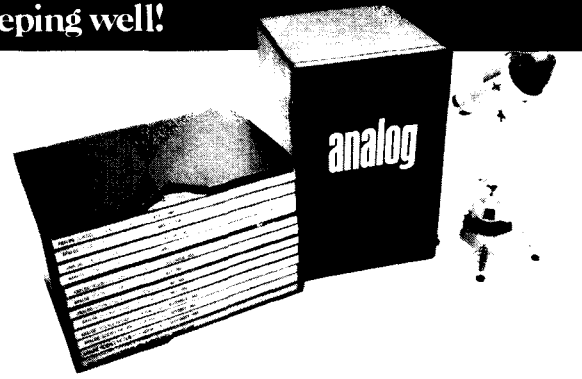

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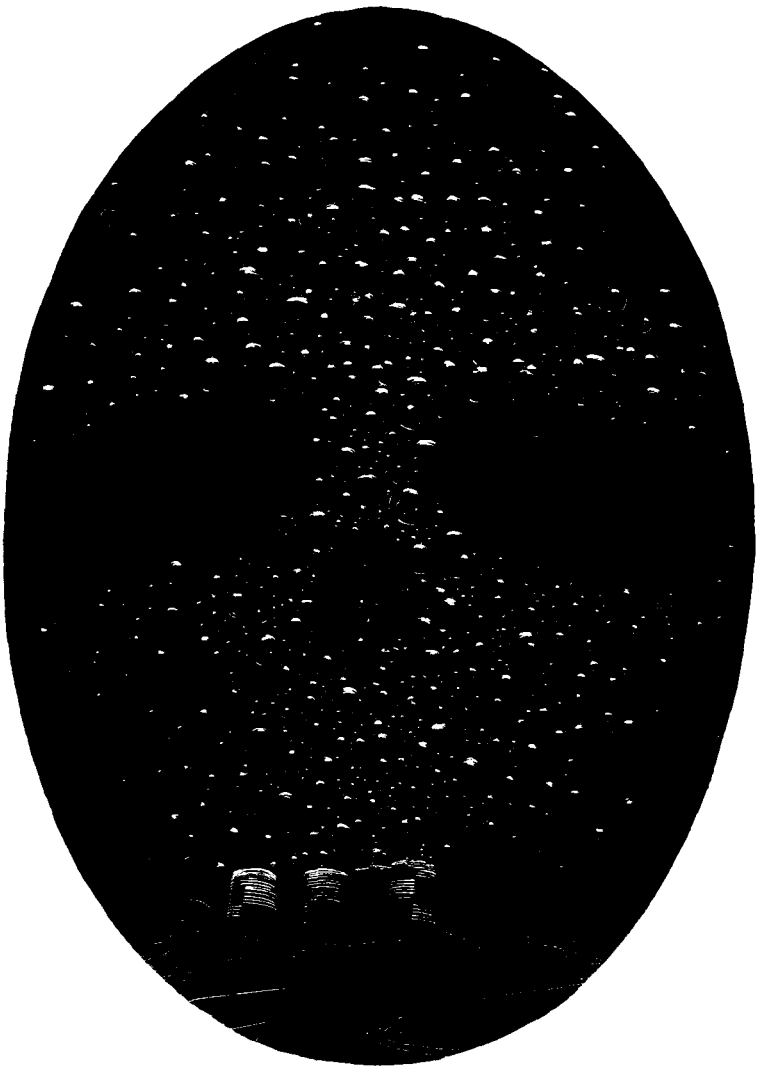

TRADE-OFF

JOHN SCHOENHERR

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There are times when the cure is worse than the disease.
But when the cure triggers other diseases . . .

R. A. BEAUMONT

Central Intelligence Agency Document 997-AH 30 March 1977

Translation of: Warsaw Pact Training Memorandum #347-9 dtd 21 March 1977 (obtained 25 March 1977). Agency Classification: Routine

Statute Classification: Secret. Transl 273 Approved: 994

Training Memorandum #347-9

From: Chief, Training Branch

To: Commanding Officers
Submarine Units
Warsaw Pact Baltic Littoral
Naval Command

To further the proficiency of electronic warfare specialists and officers on submarine courses, a quarterly training cruise will be conducted aboard a submarine equipped with multiple console stations and the most up-to-date technical education devices. In these cruise experiences, personnel will gain actual experience of sensing torpedo running sounds, detonation, surface vessel engine sounds and other signature phenomena as well as attack simulation from anti-submarine forces. These experiences will be supplemented by commentary and guidance by experienced officers and ratings, thus providing more realistic and efficient collectivized training.

Commanders will adhere to quota allocation regulations Z-4 in forwarding applications. Initial suspense date is 14 April 1977 for May maneuver exercises . . .

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From: National Security Agency
To: Off Naval Intell; CIA; DIA
EXTRACT ROUTINE RT MSG, TAPE 88967-243; 2100 5 May 1977:

Soviet Submarine (exact SN unknown) to Warsaw Pact GHQ, Naval Div: ". . . final drops of various NATO types contact-detonation depth charges made at 56 12′ N/ 20 29′ E at 1300. Final drop of live charges detonated on bottom with extreme volume and continuing secondary reverberation and turbulence. Will return Stettin directly w/ tapes for analysis."

Flash Message—Top Secret—0700050777

From: CINCNORLANT to CNO

Danish and West German Naval Commands have asked this HQ for assistance in determining cause of loss of Danish trawler personnel at 56 N 20 W approx 1700 6 May. Six trawlers with crews dead and/or unconscious and paint peeling drifting in that area. Two West German seaplanes landed in area still down on water and not responding to radio queries. Sea state regionally deteriorating with high turbulence and fog. Toxicity of unknown nature and source constitutes high risk to search and rescue personnel. Awaiting submarine monitoring and other reports from German oceanographic lab in Hamburg. May need further scientific resource backup. Will advise further developments in voice communication with you 0600 USEST.

From the New York *Times* noon teleprint edition, May 7th, 1977, page 3:

". . . The Soviet and Swedish ambassadors appeared at the White House at 10:45 this morning, cutting across the otherwise lighthearted atmosphere surrounding the scheduled christening of the President's grandson. Although they arrived in their individual cars, they spoke briefly and entered together, smiling thinly at the press's queries. It is believed by informed sources that they spoke to the President regarding the NATO alert in the Baltic Sea. When they left at 11:00, both men, still pale and uncommunicative, rode in the Soviet ambassador's car . . ."

From the internationally syndicated column "Deborah's Diary: Social Notes on the Washington Scene" for May 7, 1977 (courtesy Imperial Features, Inc.):

". . . The landing of the sleek Royal Air Force Harrier II on the White House helicopter pad this afternoon had those gathered for the christening gawking. The nose and wings were steamy in the drizzle from what must have been a very fast flight. I waved to the pilot, who was all business for a change. He was none other than Wing Commander David Evans-Thomas, currently linked by those-in-the-know in London with a certain lady of veddy-blue blood. Davey's

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passenger (male, I presume) was surrounded by Marines on his way into the White House. All very dramatic. I wonder who's bought the film rights."

Presidential Briefing 997: Professor Lars Olsson, Lund University, beginning 11:30 AM May [illegible] 1977: (also present: Secretaries of State and Defense; Director of the Central Intelligence Agency and aides noted in Register, p. 103, and Chairman, Joint Chiefs of Staff.)

OLSSON: To get to the point straightaway, Mr. President, all of my colleagues, in London, Hamburg, Stockholm, Copenhagen and in this country, concur that we have a grave problem. A toxic substance is diffusing rapidly from a point in the Baltic, just about halfway from Sweden to Poland, here. (Professor Olsson pointed to map).

PRES: Is it true that the Germans lost some of their submarine people just from going on deck? What is this stuff, anyway?

OLSSON: It is true, your excellency. It seems very likely that what has happened here is that some containers of poisonous materials cased in concrete in the late 1920s—1927 to be exact, have broken open.

PRES: What kind of poisonous material? Who the hell put them out there?

OLSSON: The material is the by-product of a safety match manufactured in that period. I am sorry to say that it was done by a firm in our country. I have some data here. If you are interested in the chemistry . . .

PRES: No, thank you, Professor. What we'd all like to know, I'm sure, is just how bad this stuff is.

OLSSON: It kills everything. Fish, plants, and even in the air over the point at which it's being released. A large number of sea birds are floating about out there now.

PRES: It's moving pretty fast then?

OLSSON: Yes, your excellency. We can't understand that.

SEC OF DEF: What's so unusual, Professor?

OLSSON: If the concrete casing ruptured through decay, then one of them—there were several, you see—should have started leaking slowly. But there's a much larger reaction involved than we would have expected.

PRES: Well, gentlemen, the question obviously comes down to what we can do about this. I can tell you to start with that the Soviets—and your government, Professor—are not happy.

OLSSON: They will be much less happy, sir, when the full dimensions of the problem are known.

PRES: What would you recommend on the basis of what you know now?

OLSSON: I would order the population of Europe within a half-mile

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of the Baltic and the North Sea to move inland immediately.

PRES: Good Lord, man, is it that serious?

OLSSON: At the very least. Mr. President, if I could use your scientific resources, and build some computer models, I could tell you more accurately what we are talking about.

CHM JCS: Mr. President, we've got a direct SSB teletype hookup standing by with all his people on site patched in to our special project computers at NORAD.

PRES: You need my approval?

CHM JCS: Yes, sir. We can't link in uncleared personnel . . .

PRES: Dave, give the general a written authorization, right now. Professor Olsson, how long will your work take?

OLSSON: About two hours. Perhaps three.

PRES: All right, gentlemen. Let's get back in here at, say, two-thirty.

(End: 11:40 AM May 7 1977)

Resumption briefing: Olsson to Pres. Speaker of House and Senate Majority Leaders also present. Beginning 2:30 PM.

OLSSON: I would like to explain how we reached our current conclusions. We used your computer to build a variety of models, to analyze aspects of the problem and then look for the best, the worst and the most normal models. I am sorry to say that there seems to be little variation among these three.

PRES: Well, what does it come out to?

OLSSON: Your excellency?

SEC OF STATE: What does it mean?

OLSSON: Of course, excuse me. Well, this substance is diffusing rapidly, in highly toxic concentrations. To be brief, the oceans of the world are threatened.

PRES: What can we do to stop it? What do you need?

OLSSON: We have given that some thought. Sinking ships full of hydraulic concrete on the site, even if we had them, would perhaps fail to do anything more than slow the rate of diffusion. The visibility's gone due to the bottom muck being so churned up. We'd have to develop safety clothing. The only bright spot in all of this is that the toxicity in the air is going down as the violent bubbling subsides.

PRES: What if it just goes on and on? That's what you're saying anyway, isn't it? That we can't do anything?

OLSSON: If it goes on and on, in a month, perhaps more, perhaps less, the oceans will be wet deserts.

SEN MAJ LDR: Just like a great big Lake Erie.

OLSSON: Excuse me, sir, no, not at all. Lake Erie has too much life. The most significant side-effect will be the death of oxygen-producing micro-organisms. I would like to extend my recommendations for evacuation, gentlemen, of high-altitude cities and countries. The Tibe-

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tans and Peruvians will be the first, perhaps, to feel the impact.

SEC OF STATE: Look, can't we dam up the Baltic?

OLSSON: To assemble and coordinate the equipment would take months, if not years. And we aren't sure what it would mean in terms of evaporation and diffusion into the water cycle.

DIR CIA: Mr. President, gentlemen. I have some slides which may give us all a better feel for the dimensions of this thing. (Slides 756-67 shown.)

SPEAKER OF THE HOUSE: It looks like a big Alka-Seltzer fizzing away out there.

OLSSON: The turbulence is caused by the reaction of the substance with sea water.

PRES: Pictures are fine, but the problem's obviously got to be met fast with realistic, practical methods. Professor, we appreciate the theoretical problems, and are grateful for your translation. Don't you see anything we can do?

OLSSON: My colleagues are almost in agreement that there is only one course. As Dr. Willistings in London put it, we may have to trade a holocaust for a nightmare.

PRES: What does that mean?

OLSSON: The use of thermonuclear devices to neutralize the source through complete vaporization.

PRES: Use the bomb? Are you kidding?

SEC OF STATE: I think what the President is trying to suggest, Professor, is that in any event the proximity of this area to dense population centers . . .

PRES: Hell, Dave. What I mean is that if you blow off one of those things that close to the Russians, we'll have instant World War III.

OLSSON: That seems quite likely, I am sure. I would like to ask the Secretary of Defense what his grimmest estimates of deaths immediate and deferred from a full thermonuclear war between the U.S.S.R. and the U.S. are.

SEC DEF: The worst? I think, about three hundred million. That's only a ballpark figure. General?

CHM JCS: 387 rings a bell. I'll check that out.

OLSSON: Gentlemen, I would like to suggest that if you wish to duplicate our study that it will merely reinforce our findings.

SEN MAJ LDR: Let me ask a question, Professor. How many bombs would be needed? And how big?

OLSSON: I'm afraid you would have to err on the side of overkill, as you call it. You see, the location is masked in mud and the by-products of reaction. Unless the material is completely destroyed, it might be merely scattered, and the rate of release accelerated. It might take, perhaps, four fifty-megaton devices exploded simultaneously around the site. General?

CHM JCS: Would the fireball have to actually encompass this material?

OLSSON: Oh, yes.

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CHM JCS: Then I'd say three or four.

SEC OF STATE: Gentlemen, do you really think the Soviets will stand by while we devastate the Baltic—with them in the fallout zone.

CHM JCS: Well, sir, the bombs would be fairly clean.

SEC OF STATE: Wouldn't there be a tidal wave?

PRES: What's the alternative, Professor?

OLSSON: Extinction of most, if not all, of the oxygen-breathing life on the planet, within perhaps six months. In a week, the Baltic, North Sea, English Channel, at least will be gone.

NAT SCI ADVISER: Mr. President, we've done our own work on this. What you've got, I'm afraid, is a grim trade-off.

PRES: Or a minimax, as my systems people love to say. Give a little, take a little.

NAT SCI ADVISER: Except that in this case we're talking about ransoming the planet with a nuclear bloodbath.

OLSSON: Perhaps you could discuss this with the Russians.

SEC DEF: When Leningrad's under water and the RADIAC meters in Moscow start breaking their needles, they'll find it a little tough to grin and bear it. I don't think I'd just sit and take it. They might think it's a trick. Or a mistake.

SEC OF STATE: We could refuse to retaliate.

PRES: Explain that a little, will you, George?

SEC OF STATE: Even if the Soviets launch a full nuclear assault after we neutralize this poison source, we could just refuse to retaliate. That would cut the total number of casualties.

CHM JCS: Oh, that's a record, even for State. The ultimate bleeding-heart sacrifice. Make the world safe for Communism.

SEC DEF: I don't think there's any point in this sort of thing. From what Professor Olsson says, we can't indulge ourselves in the luxury of hurling insults.

(End of briefing at 2:55 PM upon activation of Hotline Message Network. Transcript of ensuing message and reply (HLET 07051977-4 CLASSIFIED: *Special Executive Access Only.*)

AUTOPSY REPORT

Date and Hour Died: 7 May 1977 1530 (EDT)

Date and Hour Performed: 7 May 1977 1900 (EDT)

Prosector: (947632) Cdr. N. R. Vosberg, MC, USN; (985113) Assistant; Lt. Cmdr. L. N. Wilkinson, MC, USNR; (38635414) Maj. D. F. Pinckney, MC, USA

Clinical Diagnosis: Ht—70 inches; Wt—182 pounds; Eyes—brown; Hair—brown/gray

Pathological Diagnosis: CAUSE OF DEATH: Coronary thrombosis

Approved: /s/ N. L. Hastings, Col., MC, USA

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Military Organization: President of the United States . . .

EXECUTIVE ORDER NO. 1
May 7, 1977

Whereas immediately upon inauguration the President of the United States has been informed by the National Science Adviser that the survival of the human race is directly and imminently threatened by the diffusion of a toxic substance from a source in the Baltic Sea and whereas the party leaders of the Senate and the House of Representatives and the members of the Cabinet and National Security Council have concurred in their review of the evidence presented from scientific sources that the only course of action is the immediate multiple use of high-yield thermonuclear devices in the area of the origin of the toxic substance, the President of the United States herewith orders the Chairman of the Joint Chiefs of Staff to employ the military resources of the United States in remedy of this crisis; and further in view of the communicated threat of the Soviet government in discussions over this issue to use thermonuclear weapons should any be detonated in the Baltic, the Chairman of the Joint Chiefs of Staff is empowered to order a peremptory attack collateral with the operation in the Baltic.

The President expresses profound sorrow and regret that the alternatives have been reduced to such grave choices and recognizes the validity of arguments and long-standing concern over the use of the Baltic as a repository for industrial waste on the part of the U.S.S.R., but the United States is constrained to weigh the world's interests above all and is convinced that history will recognize the wisdom of this decision . . .

PRES US TO CG SAC ABN CP: EXTEND MY THANKS TO SURVIVING SAC CREWS STOP MEDAL OF HONOR AUTHORIZED FOR ALL MISSING GROUP CO'S PLUS OTHERS YOU RECOMMEND STOP ALL MILITARY PERSONNEL NOT OTHERWISE OCCUPIED NOW TO ASSIST IN DISASTER RELIEF IN AREAS AFFECTED BY NUCLEAR ATTACK IN UNITED STATES STOP

ALL BOMBERS FIT FOR SERVICE TO AID NAVY IN OPERATIONS AGAINST OIL SPILLED FROM ANCHORAGE TANK FARM AND NORTH SLOPE PIPELINE RUPTURED BY NUCLEAR ATTACK STOP EXPLAIN TO CREWS HOW VITAL WE NOW HALT SPILL IN NORTH PACIFIC TO PROTECT OXYGEN BALANCE AND OCEANIC FOOD CHAIN STOP

NUCLEAR WEAPON USE AUTHORIZED AGAINST SUPERTANKERS DAMAGED BY TIDAL WAVE OFF COAST OF ALASKA SEVENTY-FIVE MILES SOUTHWEST OF ANCHORAGE IMMEDIATELY STOP . . . ■

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P. Schuyler Miller

THE SF SCREEN

I owe apologies to Los Angeles fan Walter W. Lee, Jr. for mislaying the preview I wrote of his "Reference Guide to the Fantastic Films"—but I'm rather glad I did, for the first volume of his index is out, and it is far better than his prospectus and samples indicated. Moreover, you can still—I hope—get in on the pre-publication price: $22.50 for three fat volumes, of which "A-F" runs to over 200 pages. Once all three volumes are out, you will pay $28 for the set. The individual volumes are $9.50 each, as they appear. Your orders go to Walt Lee, P.O. Box 66273, Los Angeles, California 90066.

What Walt Lee has done is to search the abundant literature on motion pictures for everything he could find on science fiction, fantasy and horror films. He isn't passing on hearsay: volume one has eleven pages of films that have been called fantasies on other checklists, and aren't. Another section of "Problems" lists films that may be SF or fantasy, but which he hasn't been able to check. (His list of sources runs to eleven pages.)

Films are listed alphabetically by title, with basic production data, date of release, production credits, as much of the cast as can be determined (though not their parts, in most cases), alternate titles, sequels, other versions . . . in short, everything a film buff wants to know. The book is illustrated with a variety of stills from the rarer or more important films—and not the ones you've seen over and over again.

This is a tremendous job, that has to rate with the great SF indexes. Walt will send you an information sheet if you send him a self-addressed return envelope.

Walt Lee's "Reference Guide" is exactly that, intended primarily for students of SF films. You'll find more pictures but less information in Denis Gifford's "Science Fiction Film." This is one of Dutton's "Studio Vista Pictureback" series, and costs $2.25 for 160 lavishly illustrated pages. Gifford has done a book on "Movie Monsters," in the same series, which I haven't been able to find. It probably accounts for his skipping such classics as "Frankenstein" in this book. He presents a running chronicle organized by theme—inventions, exploration, prediction, with many subdivisions—but the book is really not much more than a title-dropping excursion through time, with a sentence or two to characterize or comment on each film. It's about as

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much as I give you when I report the contents of a really long anthology.

I think you'll really enjoy "Focus on the Science Fiction Film." This is an anthology edited by William Johnson, in the "Focus On" series of paperbacks published by Prentice-Hall (192 pp; $2.45). Of special interest to Analog readers is the still-fascinating account of the making of "Destination Moon" by Robert A. Heinlein, published here in 1950, and the comments of a number of SF "names," including John Campbell. ("Most films billed as science fiction are in fact fairy stories.") The selections have been drawn from far and wide—science journals as well as the cinema literature, European as well as American and English. They include critical reviews, essays, articles like Heinlein's, an account of the first Trieste Science Fiction Film Festival, and a good deal more. (Incidentally, there is a report on the 1972 Trieste Festival in the July/August issue of *Luna*, the handsome monthly fanzine published by Franklin and Ann Dietz of 655 Orchard Street, Oradell, New Jersey 07649. A copy is 35 cents; a year costs $4.00 in the U.S. or $6.75 outside North America, sent first class. I don't know any fanzine that covers world SF so well.)

I think you may also enjoy the paperback based on Stanley Kubrick's "Clockwork Orange" (which I still haven't seen) and published by Ballantine for $3.95. Someone, possibly Kubrick himself, has selected a series of frames—images—from the film and combined them with snatches of the dialog and narration to give you a running pictures-with-words impression. The words come off second-best, if you recall Anthony Burgess' remarkable novel, but the choice of pictures gives you a vivid impression of cinematic techniques. This is *not* just an illustrated script; it's a different way of presenting a film, and an effective one.

THE OVERMAN CULTURE
by Edmund Cooper • G.P. Putnam's Sons, New York • 1972 • 190 pp. • $5.95

The credit list at the beginning of this latest book by a consistently good, if unspectacular, English writer, has several books that I haven't seen. They may have been published under different titles in England and the States. However that may be, this is a real spinner.

Michael is a "fragile" boy—one of a seemingly small number of children who grow tired when they run, who bleed when they are hurt, who can't take off their heads. He lives in a London in which Queen Victoria comes in a hovercar to attend the premiere of "Captains Courageous," with Sir Winston Churchill waiting to introduce Mr. Spencer Tracy and Master Freddie Bartholomew. There is a newsreel of the Germans bombing Vietnam and the Russian base on the Moon, and after the festivities people pedal off home on their bicycles.

As the fragile children discover each other, probe in the moldering ruins of London, and try to interpret what they find, they come to

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the conclusion that they have been created by some super-scientist, as guinea pigs for an experiment. And what happens if the guinea pigs turn on their creator—on the Overman of the legend they all know? They may be destroyed. They may be set free. They may escape. And who or what are the others, the drybones who do not bleed, who can take off their heads? Are they part of another experiment? Are they the experimenters?

Because you have been brought up in science fiction, you will have a pretty good idea of what may be going on. But Edmund Cooper has secrets he can hide as well from you as from the fragiles. His book isn't great SF, but you'll enjoy it.

THE WRONG END OF TIME
by John Brunner • Doubleday & Co., Garden City, New York • 1971 • 204 pp. • $4.95

When you read this, the 1972 elections may have decided whether we as a nation will continue as members of a world community, or whether we will pull the covers over us and lie gnawing our knuckles, scared to the point of hysteria. In the future John Brunner shows us, we have followed the second course and created a "festung Amerika," stewing in its own rotten juices.

To this America, terrified of the world in which it finds itself, comes a Russian agent, an "enemy" with news that we are no longer alone. Out at the rim of the solar system is a new and alien force with powers that we can barely imagine. Earth as a whole must join forces to save itself . . . and that is very nearly impossible.

Somewhere in the American underground is a young black man, Dantry, "born at the wrong end of time." Somehow, Dantry is the solution, or knows the solution, to the problem of the menacing Alien. Sheklov has to find him, before the Establishment finds him, before it is too late to use what he knows.

Sound ordinary? It isn't. Because John Brunner has also written into his book a legitimate mystery—the mystery of Dantry's "secret," who he is and what he is. You may be able to solve it, or you may not. Yes or no, it shouldn't spoil a fast-moving story for you.

THE REALITY TRIP
by Robert Silverberg • Ballantine Books, New York • No. 02548 • 210 pp. • 95¢

This collection is subtitled "and other implausibilities" . . . a total misnomer, for Bob Silverberg can make practically anything plausible, even when the skeleton of the story is highly decalcified and flabby.

The book opens with "In Entropy's Jaws," the often-anthologized story which interweaves psi, time, and many simultaneous selves in a fascinating and bewildering way. The "new" film-inspired techniques make the story, whereas in so many cases they destroy it.

The collection ends with the original novelette or novella version of "Hawksbill Station." I still can't decide whether I like it better than the expanded novel, which shows very few stretch marks.

In between is a sample of every-

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thing. In the title story, aliens are among us, disguised as men, and finding Earth far too attractive. In "Black is Beautiful," New York has become a black tourist trap, and the segregation versus integration battle of our day is still being fought out in the black community. (Presumably, blacks will pass this off as a honky attitude.)

"Ozymandius" takes us to a planet where a talkative and informative robot stands guard over the dust of a long-dead race. The use that will be made of the robot's information is bitterly inevitable.

"Caliban" is the one deviant in a society where conformity has become total. Men and women can have their bodies remade to fit the current pattern—even when it is a survivor from our time, ugly and misshapen as he is.

"The Shrines of Earth" was here back in 1957. It's a slight enough story, showing how the country simplicities of Earth hoodwink their galactic betters into providing protection against invasion. (Even this isn't too implausible.)

Finally, "Ringing the Changes" is a fairly obvious story about a machine louse-up, which results in a group of personalities being separated from their own and their host bodies. Problem: how to match them up again. Solution: unsatisfactory.

I think it is safe to say that you can read any Silverberg book profitably. If he goes in for total recall, like Isaac Asimov, I may have to retract, but not as long as these collections bring together his recent work.

PSTALEMATE

by Lester del Rey • G. P. Putnam's Sons, New York • 1971 • 190 pp. • $4.95

The public fascination with ESP, "occult" powers, and other facets of the field science fiction has generally labeled "psi" (and most people consider magic—and believe implicitly) has rather changed SF's approach to the subject. On the one hand, it has been absorbed as something as ordinary as gravitation. On another, it is the rabbit that the hero pulls out of his sleeve when he needs a miracle. Lester del Rey has waited ten years to show us how it works.

This, in itself, isn't all that new: others have done it, and some more forcefully, but probably nobody more persuasively. Harry Bronson is the unbeliever who discovers to his horror that he is charged with all kinds of psi powers. He finds that he is one of many, of a scattered group of people, lonely in their isolation, yet afraid to contact each other. Most of them break under the strain and become insane . . . and as an engineer, Bronson is compelled to attack the problem rationally. Why does insanity seem to be inevitable? Can the process be described—and blocked? Can it be sidetracked into something useful instead of harmful?

Involved in all this is Harry Bronson's personal life—an insane mother, a quack as a father, a girl who is going his route. Read it for the story alone, and you'll find more than enough to keep you going.

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This is a book that just might be filmed without ruining it. It wouldn't be expensive, like gadget-SF films. It would capitalize on the current ESP craze. But it would require good acting, preferably by nobodies who don't have to play themselves, and direction that has enough integrity to let the film tell the book's story in the book's way.

THE DARKNESS ON DIAMONDIA

by A.E. van Vogt • Ace Books, New York • No. 13798 • 254 pp. • 95¢

A.E. van Vogt objects to my saying that he created the "wheels within wheels" school of science fiction, in which the reader is never really sure what is going on until all the threads are caught up and tied together at the end (and sometimes not then). He is right, of course. In the mystery field, Harry Stephen Keeler was at it earlier and carried it to the point of self-parody. The original "Lenaman" stories, here in Astounding, were built up in the same way (which "Doc" Smith spoiled in the books by telling the reader what was going on behind the scenes).

However all that may be, van Vogt spun his intricate constructs with a force and speed that swept the reader off his feet and kept him struggling and gasping until he dragged himself to sound ground at the end. He wrote more memorable, and truly "classic," stories in the early years of Astounding than writers with more stylistic and critical oak leaves pinned on their chests. And he's doing it again in this spell-binder.

To try to dissect a van Vogt plot is ridiculous; you have to experience it. Ace has done a very fair job of suggesting the confusion of this one in its introductory page, titled "The Diamondian Puzzle." Read it, and if you're trapped, buy the book . . . because all the seeming contradictions and paradoxes set forth there are really true.

Van Vogt's "big" books are usually constructed around some philosophical concept—for example, the General Semantics core of the "Null A" books. In this case, it is something called "finite logic," which is far outside my own expertise or experience. It is set against "modern logic," which treats all individuals as interchangeable, and hence subject to statistical manipulation. (Was that Hari Selden's secret in Asimov's "Foundation" stories?) You'll find the meat of the matter explained 'way back on page 175 of the book.

Meanwhile, you'll find yourself caught up in the struggle of human colonists against the not-really-human Irak guerrillas, with evidence of meddling from "outside" in the form of the Darkness. You will have to figure out what the Lositeen Weapon is . . . what the DAR Building is and can do . . . whether the "hero" of the book is Colonel Charles Morton, or David Kirk, or Captain James Marriott, or Lieutenant Lester Bray, or Isolina Ferraris, or somebody quite different . . . and whether, indeed and in the end, "all men are Morton."

I haven't had so much fun since van Vogt's early days.

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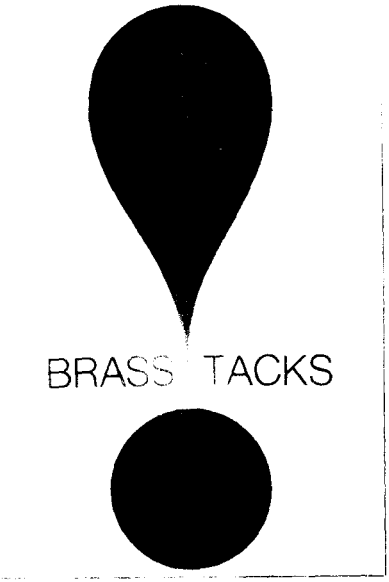

We received quite a few responses to R. G. Cleveland's article, "The Future of Automotive Power Plants," in the July issue. Here is Mr. Cleveland's reply to the points raised.

Dear Ben

Regarding one misconception in my article: some people seem to've gotten the idea that I was describing what I advocate regarding the future automotive power plant. I wasn't. I was describing what I think the evidence shows the future automotive power plant *will be*. Something else (such as steam) might be better than gas turbines; nevertheless, I still think the gas turbine is what we'll see from Detroit in 1975-76.

One party refers to high-performance cars as "death machines." Nonsense. You can die as easily in a 40-horsepower VW as in a 450-horsepower Corvette, and there is no evidence that the 'Vette is more likely to have an accident. (Insurance companies discriminate against such cars because of theft rates, and because they cost more to fix.) It's still, and will always be, the "nut holding the wheel" that causes accidents. Furthermore, the technology already exists to virtually eliminate death on the highway (death, *not* accidents). It was developed by and for that horrible, awful sport, auto racing. Crashes of incredible violence and at extremely high speeds (150-180 miles per hour) are common in stock car racing; yet the drivers are very rarely killed. Why? Because they are securely strapped into the cars, and the cars are built with enormously strong roll cages that make serious injury to the vehicle occupants almost impossible, unless it catches fire. Detroit could do this, and cut highway deaths an order of magnitude or two. They don't, because the public would scream that the roll cages are ugly and inconvenient. Most people don't even wear their seat belts!

One lady who neglected to give a return address wanted to replace cars with backpack helicopters. Interesting, maybe even possible . . . but let's face it; that is *not* going to happen. Therefore, it has no real place in an article like mine.

Some think that a different form of reciprocating piston internal combustion (RPIC) engine could do the trick. Look, folks, dirty burning is an inherent characteristic of *any* engine with a pulsed combustion cycle. With a limited time for burning you can *not* completely oxidize all the fuel. Period. Air-

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craft, motorcycle, industrial, and other forms of pulsed combustion engines all share this problem. These engines could be cleaned up only by use of a satisfactory catalytic muffler or afterburner, which has yet to be achieved in practice.

One reader was concerned about oxygen consumption, rather than air pollution. But the total oxygen consumption from all human activities is nowhere near that from other, strictly natural processes. Furthermore, though green plants in a few local land areas have been affected by pollution, just as has ocean plankton in a few strictly local polluted areas of the continental shelves, this isn't a planetary thing. The pollutants are unstable both in air and in seawater, and the tonnage of both (5.5×10^{15} tons of air; 2.8×10^{18} tons of seawater) is so great that the total mass of planetary flora is virtually unaffected. Therefore, the automatic air renewal system of the planet remains intact and self-regulating, and the problems are, and will remain, local.

This covers most of it. Remember: this isn't what I think *should* happen; it's what I think *will* happen. The problem is strictly temporary anyway. Eventually, fusion power is sure to arrive, and will give us fusion-electric cars which are strictly nonpolluting and can be fueled from the kitchen sink.

R. G. CLEVELAND

Dear Ben:

I read "The Future of Automotive Power Plants," by R. G. Cleveland, with a great deal of interest, but I'm afraid I disagree with his important final conclusion—that the ultimate solution to the problem of air pollution by automobiles is the "water-fueled, fusion-powered electric." He bases this on the assumption that the electric motor is a "zero-pollution" device.

The conclusion would be fine, but the premise just ain't so. I don't care if it's powered by fission, fusion, or batteries, any electric motor that is drawing 85 amps at one kilovolt creates a very dangerous pollutant—ozone. Molecule for molecule, good old O_3 is more dangerous to life than CO_2 or any of the oxides of nitrogen. And more corrosive.

Even a little quarter-inch drill puts out an appreciable amount of the stuff, and the older an electric motor is, the more it produces.

I doubt if Los Angeles would be any better off than it is now if it contained six or seven million of those thousand-volt, 85-amp ozone generators.

RANDALL GARRETT
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It's not all that bad. There is no fundamental reason for an electric motor to generate ozone, although electric autos might need to be "tuned" as often as gas buggies to keep them ozone-less. Ozone itself breaks down fairly quickly into harmless molecular oxygen, and would pose a far smaller problem than smog-producing hydrocarbons and oxides of nitrogen.

Dear Mr. Bova:

R. G. Cleveland's July science

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fact article was an excellent summary of Detroit's inept handling of the automotive pollution problem along with an analysis of propulsion options to the internal combustion engine. The most assured technological forecast that can now be made, however, is that cars will never be powered by individual fusion reactors. Some seventeen different approaches to achieve controlled thermonuclear fusion in a plasma through magnetic or electrostatic confinement have confirmation in U.S. and foreign labs. The proven physical constraints of each of these systems are such that the plasma must reach a certain minimum density and temperature range before more power can be extracted from the fusion reactions than is used in maintaining the plasma. This break-even point is somewhat similar to critical mass parameters in fission systems except that the volume would be much larger in any fusion system. From a size standpoint it is questionable that a fusion reactor could power anything smaller than a five-thousand-ton submarine.

An alternate approach to the above-mentioned plasma confinement schemes is to induce fusion in tiny pellets of fuel through focused laser energy (six to nine or more separate lasers). Here again, there are minimum size constraints in reaching the break-even point. Theoretical limitations in the generation of laser energy would also rule out a small fusion reactor.

Thermonuclear fusion reactions are an even more formidable barrier. Fusion is most easily induced (allowing the smallest reactor in volume) between tritium and deuterium, which releases three-fourths of the reaction energy in 14.1 Mev neutrons. A deuterium-deuterium fuel combination would release about half of its energy in neutrons averaging 2.7 Mev. The fusion of helium$_3$ and deuterium releases no neutrons, but there would be some side deuterium-deuterium reactions in any system using this fuel combination. The fusion of lithium$_6$ and a proton (ordinary hydrogen) produces no neutrons. In the order presented, these fusion reactions are progressively more difficult to achieve and each in turn would require a larger reactor, higher plasma temperatures, et cetera. Perhaps a whale-sized extraterrestrial on the planet Zkmxxylj drives a fusion-powered land vehicle, but don't expect one under the hood of the "Ford in your future."

Coils of metallic hydrogen or some room temperature superconductive compound may eventually store very large quantities of electricity for automotive propulsion. They could also turn into rather impressive bombs if their temperature is raised past the superconductive transition point in a vehicle accident or through system malfunction. No doubt Century Twenty-one will witness some surprising propulsion innovations, but fusion will be restricted to large power plants and orbit-to-orbit propulsion for very large spacecraft.

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And bumblebees can't fly. Negative predictions are almost impossible to prove; there's always next year. Now, if large stationary fusion power plants were available, maybe they could provide the power for recharging battery-driven autos.

Dear Mr. Bova:

In a recent issue of Analog you had an article about the problem of emission controls from automobiles—and the various possible cars of the future. Your author basically assumed that the emission standards of 1975-76 could not be met by the automotive industry. I believe it is probably more correct to say that the industry doesn't want to meet them.

However, the July 1972 number of the *Platinum Metals Review*, published by Johnson Matthey, one of the major companies in the platinum metals field, has an article on this matter of meeting the emission standards. The abstract reads as follows:

"Stringent regulations governing automobile exhaust emissions are due to come into force in the United States. Johnson Matthey have undertaken the development of platinum-based catalytic reactors for control of these exhaust emissions. Two new types of catalyst have demonstrated the feasibility of exhaust control by catalytic means, and have been incorporated in ten vehicles to achieve emission levels well below the specified levels for 1975 and 1976 model year cars. Extended road mileage on the former system has shown that good durability can be obtained, with emissions below 1975 limits for 25,000 miles."

The abstract is conservative. By the use of double catalyst systems, both carbon monoxide and NO_x can be controlled. The work assumes the use of lead-free gasoline, although the tests show little adverse effect on the catalysts by either lead or the phosphorous-containing additives used for preignition control and oil stabilization.

So it can be done! They say that these materials are under test by the major car manufacturers of the world. Maybe we won't see a revolution. After all, the Wankel will put out emissions too.

HERMAN KERST
310 Woodbridge Road
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If I owned a platinum mine, I'd be overjoyed at the prospect of platinum-based catalytic converters. I might even oversell their efficiency and efficacy! But how much platinum will we need to handle all the automobiles? And how much platinum is available in "them thar hills"?

Dear Mr. Bova:

I am afraid Mr. Cleveland is mistaken when he sees a bright future of turbine cars around the pollution corner. Turbine cars are with us ten years hence, and the turbine is a fine power plant except at partial load and/or speed, where it is inefficient despite big and expensive heat-exchangers. The turbine car in town will gobble up three times as much fuel and produce three times as much hot ex-

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haust gases than the piston (or Wankel) car.

This is inadmissible even if the gases are inherently cleaner than those of the piston engine. Thus, the turbine will be useful for long-haul trucks and long-run buses only.

Mr. Cleveland implies that we have no infinitely variable torque converter. Such a converter, mechanical, is built into the small Dutch Daf car and the Dutch, formerly addicted to big American cars, are using it more and more. Further, each automatic drive is an infinitely variable torque converter, hydraulic. The additional gear box serves only to better its efficiency, which, as with all turbines, is low at partial output.

The steam engine has low efficiency at all outputs and must thus share the objections against turbines only more so. Mr. Cleveland has already shown that an electrical car based on accumulators is hardly viable. He forgets the Stirling motor, which, while very efficient, seems to be cumbersome and thus reserved for the heavy-weights.

Most of all he overlooks the possibilities of the RPIC, which are by no means limited to a catalytic cleaner. I understand that methane, liquefied as well as compressed, is being tested as fuel for heavy trucks (insulated or pressure tanks being heavy) and that it burns, due to its utter chemical simplicity, very cleanly and efficiently. About the same should hold true of liquefied propane (bottled gas) in a car. Filling your tank under pressure would complicate things, but changing bottles is easy. Methanol, the alcohol from methane, should also give a clean exhaust.

JUAN LOEWENSTEIN
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The power of modern technology is just starting to be applied to the automobile engine problem. For example, if modern heat transfer techniques were applied to the now-bulky radiator of the Stirling engine, the quiet, efficient, low-pollution Stirling might become compact enough for autos.

Dear Mr. Bova:

Just finished the science fact-fiction article, "The Future of Automotive Power Plants" in the July issue of Analog. Congratulations to (nom de plume) R. G. Cleveland for a concise report covering an astounding maze of fact and conjecture (part of the reason for the fact-fiction). At first I objected to his offhanded ignoring of factors that I feel are very important in establishing the parameters of the problems. The overall presentation, however, overcame most objections, and was the best analysis I have seen covering *almost* all of the alternatives. One premise at fault is that performance is based on two factors: top speed and acceleration. The only cars concerned with *top* speed are racing cars. Now don't get me wrong! I have been building and racing cars in a small way since 1948, and I love 'em. What we are talking about are people cars. The machines the "other ninety percent" are driving. The

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true factor is the torque characteristic necessary to maintain a predetermined maximum cruising speed (plus safety factor) and a comfortably fast acceleration for entering fast lane traffic.

One example, my 6,000-pound Continental (460 ci engine, 375 hp, at 4,600 rpm) cruises at 70 miles per hour, the legal speed limit, at about 25 percent throttle and 2,200 revolutions per minute. This means that a 100-horsepower engine would push this monster down the road at the legal speed limit. This car's acceleration is comparable with some of the "pony cars," which one wouldn't get with the 100 hp engine, so let's put another 100 hp engine in reserve just for acceleration. Now, this 460 ci engine develops 500 ft/lbs torque at 2,800 rpm, which is in the normal shift range for freeway entrances and emergency kickdown escapes (500 ft/lbs at 2,800 rpm = 266 + hp). This means that two 100 hp engines running at optimum output should be adequate for normal contingencies for this 6,000-pound machine, and one of them could carry it on normal occasions.

On this basis, the 2,100-pound car is somewhat over-powered with its 100 hp engine, *except when it is accelerating.* Contrary to Mr. R. G. Cleveland's belief, rolling friction comprises the major portion of drag from town speeds up to about 75 mph, where it becomes about 40 percent of the drag and rapidly increases as the speed increases. (See *Road & Track*, February 1961.) Oddly enough, car size doesn't have as large an effect on the drag factor as other variables such as radial tires versus bias, disc brakes versus drum, ball bearings versus roller, et cetera, so an electric car should have less rolling friction than a RPIC engine car.

An alternate to the options discussed by R. G. Cleveland would be to have a constant-rpm turbine (gas or steam) driving a generator with output capacity equal to 75 mph torque requirements plus, say, ten percent. There would also be storage cells (batteries, capacitors, what?) that could be fed into the system via the "kickdown switch" on the accelerator for that two percent (a guess) of the time that the additional torque is needed. A constant-rpm turbine is considerably cheaper to build than any of the other systems mentioned; also, the same power plant could be used for almost all cars and the storage capacity would vary directly as the needs of the car.

Of course, the turbine wouldn't run full speed *all* the time. In town at traffic lights, or stalled in slow traffic on the freeway, a demand sensor would let it idle until enough load was present to bring the turbine back up to speed, and this could be done at long-enough time intervals to prevent see-saw operation.

One very important item Mr. Cleveland didn't mention is the high energy consumption of cold weather heating and 100-degree summer cooling of the cars' occupants. The power required here is too great to expect a battery-powered auto to handle at all, whereas the constant-speed turbine would

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have no trouble furnishing both waste heat winter heating and summer cooling with an electric blower and a compressor run from a power take-off on generator drive shaft.

Maybe I should have written to Lear?

C. W. ASTON

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Aston Design Development Company

One simple and overlooked solution to the problem is to ban private autos inside city limits, and reserve them for "turnpike" type country driving. Cities would use public transportation, and autos could be design-optimized for high-speed, long distance driving.

Dear Mr. Bova

Having recently read "The Limits to Growth," I find that I disagree with the conclusions that you draw in your August editorial, "The Disasters that Weren't."

The MIT group *did* compute a case where resources were assumed virtually boundless (page 132, Fig. 37), only to find that pollution produced the same catastrophic crash as lack of resources or overpopulation had led to in previous models. Thus, a limitless supply of raw resources from other areas of the solar system cannot be the panacea for all of Earth's problems. Waste disposal commensurate with the rate of resource utilization must be put in effect to take care of the pollution problem. Similarly, controls on population growth must eventually be imposed, if only to keep people from stepping on each other's toes.

Such controls need not be oppressive; they may even turn out to be unnecessary if everyone recognizes the nature of the problems. The world of zero-growth need not be grimly totalitarian. It might well, however, be suffocating, and I think this is where the long-term social relevance of the exploration of space really lies: it leaves a door open and a path to explore for the adventurous souls of a world grown old and quiet.

PAUL H. LEBLOND

3555 Dunbar
Vancouver 8, B.C., Canada

As I said, there are limits to growth. But while the MIT study considered our one planet as a limiting condition, we can consider the whole solar system.

Dear Mr. Bova:

I think you are a little overconfident about the abilities of technology, and this is why I would like to comment on your August editorial, "The Disasters that Weren't."

First, a minor point: you seem to misrepresent the position of the opponents of Amchitka. They did not say earthquakes (and tsunamis, and radiation leaks) were certain; they said they were possible, and that the risks outweighed the advantages. The fact that no earthquakes occurred is therefore a point against the nongovernment scientists' position, but hardly the annihilating victory for the forces of reason that you make of it.

Whatever the facts in that case, I

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don't think your sanguine views on population and pollution are defensible. You present the results of "The Limits to Growth" quite well, but ignore them throughout the editorial. Apparently you haven't learned what Isaac Asimov, for one, was pointing out a decade ago: *no* exponential growth rate can be sustained indefinitely.

Your optimism on population trends seems built on hopes alone. The population growth of Latin American countries shows "signs of slowing down"? *Signs* are not enough; and many countries there and in Africa would be headed for disaster *with half their present* growth rates. The U.S. is approaching replacement level? Encouraging, but not enough, particularly with the baby-boom fallout approaching childbearing age. Japan and Formosa have stabilized their populations? Certainly not; they have reduced the growth rate, and hopefully will stabilize in future, but the battle is not yet won. For instance, Japan's growth rate, sufficient now to double its population in eighty years, is going up now under pressure from cheap labor elsewhere; Taiwan has not even had Japan's success. The India proposal is pie in the sky, and unlikely to influence attitudes strongly; they'll probably never reach the level of the U.S., and look how sensible education has made us! Not very.

The green revolution is encouraging, but only takes some of the pressure off. A breathing space is not a solution . . .

Finally, you ask: Are our resources finite? I must very firmly contradict you here: the answer is *yes!* The solar system may increase some of our resources by one or two orders of magnitude, but this is not infinity . . .

The question is really not *should* we stabilize, but *when?* I'll admit that I consider it possible, if improbable, that we'll be able to avoid eco-catastrophe and population implosions, but at best we're unlikely to do better than muddle through crisis after crisis, with the life style of everyone getting worse each time. Even if we survive it all, and technology works all the wonders we can imagine, we must consider whether adopting sensible policies now wouldn't make things better. Your tenth-generation descendants may be satisfied to live in an urbmon or on a Ringworld, but wouldn't it be better if we left them other alternatives?

I think anybody who wants to make a pronouncement on population should read "The Population Bomb" first and see if it answers his call to optimism; I gather you haven't. Let me recommend it to you. It's apocalyptic, but it makes sense and it's well written.

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The point is that these growth rates are not *exponential; the curves are already starting to flatten—albeit slightly. As for "The Population Bomb," it has been praised by many—but few of them are professional scientists specializing in population studies!*

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EDITORIAL

continued from page 8

meaning emotion they can feel, and the only instinctively satisfying way to repay the insult is in blood. The greater the fear, the more certain such payment becomes.

The Tribesman will never present such a threat; he will always seek to maintain the cultural status quo. The Barbarian, however, will destroy any culture that tries to impose excessive restraints upon him. He must. He is inherently incapable of tolerating such restraints, and no culture will long survive the attempt to impose them.

So only a libertarian culture, with the necessary restraints kept to a minimum, can survive its Barbarians. There is no viable alternative. Even if it were possible to eliminate the Barbarian genes from the race (very doubtful), a culture that succeeded in this would cripple itself, and be meat for the first competing culture it met.

For the contribution the Barbarian can make to a compatible culture is at least as great as the threat he poses to an antagonistic one. His orientation, with respect for nothing but personal achievement, guarantees a level of personal achievement far above that of any Tribesman, or many Citizens.

For instance, a Barbarian makes a superlative combat (and a lousy garrison) soldier, given only a leader he can respect. He'll follow such a man into hell itself, because *trying to live up to that example increases his sense of his own personal achievement.* He has neither respect for nor loyalty to laws, principles, or governments. And he won't tolerate a leader he *doesn't* respect; this is why incompetent combat officers last such a short time at the head of seasoned troops.

However, the heads of a civil culture's military had better not be Barbarians. A Barbarian commanding general, with no basic cultural loyalty, will use his army for his own purposes the first time it's to his advantage. In the later days of the Empire, for instance, the Roman legions did this sort of thing quite frequently.

Of course, the culture may be a monarchy, with the monarch the respected leader of the Barbarian general. The army can then be relied upon . . . as long as that monarch retains the throne.

The same considerations, of course, apply to police forces and other paramilitary organizations.

Some Barbarians, though, prefer to be on their own, leaderless. They may become the leaders of other Barbarians, like the Spanish Conquistadores. Otherwise, they excel at professions like test pilot, professional athlete, explorer . . . anything that demands individual excellence and judgment. Daniel Boone and the other frontiersmen

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were this sort of Barbarian. Such jobs they can do better than anyone else, since they neither need nor want close supervision. A culture which provides its Barbarians with the right sort of occupation will find them very useful members indeed.

Barbarian women are just as individualistic and strong-willed as Barbarian men. However, Women's Libbers, who despise the Tribeswoman, find the Barbarian woman incomprehensible. (She will find *them* ludicrous and pitiful.) They simply cannot understand how such a strong-willed woman can seek, and enjoy, being dominated by a man. *They* wouldn't!

Actually, they're working from a false premise. A Barbarian woman isn't seeking male domination, just as a Barbarian man isn't seeking a boss when he follows a leader-hero. In fact her mate *is* the Barbarian woman's leader-hero. She is most attracted to the man she respects most, and once mated, her loyalty to him is absolute. He will, then, *appear* to dominate her.

Appearances deceive. Barbarian men obey their leaders out of respect and adulation; Barbarian women obey their men out of respect and love. "Obey" . . . sort of. The Barbarian marriage, between two such powerful personalities, is usually turbulent. He commands; they argue; he usually wins, sometimes through physical force. She doesn't mind this. It reaffirms her respect. (Unless he overdoes it, in which case she'll probably knife him the next time.) If she started winning, he'd lose her respect, and her love is tied to that respect. She doesn't need to win; women have other ways of getting their way. But loyalty ties her ultimate goals to his . . . and since she is usually a pretty high-level person, she is likely to be a very helpful partner in his life and doings.

The Barbarian, becoming a Citizen, acquires no basically new traits. He hasn't changed in the same way as the Tribesman-turned-Barbarian, by switching to the opposite end of the scale. Rather, the Citizen is a swing back from the extreme of the pure Barbarian toward the Tribal end of the scale.

The Tribesman-turned-Barbarian rejects the Tribal values *totally*. He respects only individuals . . . *certain* individuals. He is loyal to leader, friends, and family; but to no larger group at all, including culture and country. The Citizen is the Barbarian with social responsibility added. He is still an individual. He hasn't (Barbarians note!) reverted to a crawling slave of the state. He has decided that, besides (not instead of) being an individual, he owes a higher loyalty to a larger group (such as a country or culture) of which he is also a member.

Only through Citizens can any democratic machinery of govern-

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ment function. Such government is impossible in either a Tribe or a Barbarism. The Tribesman isn't interested in voting. He wants a source of answers; not the need to decide for himself! The Barbarian is interested, but knows his individual vote has no effect, so he doesn't bother. It's useless to tell him, "If everyone did that, the system wouldn't work." He isn't everyone. He controls only his own vote; therefore the argument is meaningless.

Only by the "Sirhan Sirhan method" does an individual vote count. No Barbarian, however, would do this. Barbarians kill only for personal reasons (sometimes including pay), never for principles. Sirhan is a Citizen (of the Arab World), for he killed from a form of patriotism, a meaningless term to a Barbarian. (The theory that the motive was an infantile desire for attention is just plain silly.) *That* individual vote *did* count, for without it, Sirhan's victim could almost certainly have been elected President of the United States in 1968.

A Citizen votes and obeys the law because it is his civic duty; a higher duty than he owes himself and his in-group. With a high enough percentage of such people in governed and government, a democratic government can function.

When Barbarian meets Citizen he may see no difference. As individuals, there is none; it exists only in the Citizen's relationship to his culture. Barbarians find civic cultural motives incomprehensible; but soon learn that many Citizens are worthy of respect as individuals, and some Citizen cooperative groups capable of stupendous achievements . . . like Moon voyages. This is why Citizens who are capable enough can lead Barbarians. One need not understand electricity to respect lightning.

But the Citizen attitude has its own weakness. "The highest duty of an individual is to his culture," is only a short step from, "Cultural needs are more important than individual rights." ("Ask not what your country can do for you, but what you can do for your country . . .") The Tribal/totalitarian ethic that the individual exists only to serve the state differs only in detail. If the civil culture is libertarian, this difference is large. However, it can become vanishingly small, in which case the civil culture becomes an absolute totalitarian state. The Citizen's weakness is his receptivity to arguments such as: "The streets of our country are in turmoil. The universities are filled with students rebelling and rioting. Communists are seeking to destroy our country. Russia is threatening us with her might, and the republic is in danger. Yes, danger from within and without. We need law and order, or our nation cannot survive."

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The quote is from a speech delivered nearly forty years ago . . . by Adolf Hitler. He convinced the German Citizens that Germany *needed* a Total State . . . which it got, with all its enormities. Only the intervention of overwhelming outside force succeeded in smashing the matrix.

But don't put down the German Citizens for allowing this. Hitler succeeded, not because he was dealing with German Citizens, but because he was dealing with Citizens. Theoretically, *any* true Citizen could be sold on such a program. You need only convince him that it's vital to The Security of his Country.

All originally libertarian civil cultures tend to evolve this way. Not (usually) through inherent evil in the people responsible, who see "ills" of the culture they sincerely believe *must* be cured by any available means. This was true when republican Rome became the Roman Empire; when the Republic of Germany became the Third Reich; and is equally true of certain political elements in today's United States.

Citizens have always permitted this, "for the Good of Society." The process continues until the Barbarians, unable to live under the increasing oppression, smash the culture for their own survival. Citizen elements then take over and form a newly libertarian government/culture, which starts the cycle anew.

But the Parabarb sees another possibility.

The Barbarian, rejecting *all* responsibility to the culture, carries individualism too far. But the Citizen, making his *highest* duty that to the culture, carries social responsibility too far. He is a patriot. ("My country, right or wrong . . .") The Parabarb is not. He has social responsibility minus cultural loyalty. The Citizen's culture/country is sacred; the Parabarb's is only a social tool, an arbitrary arrangement among members of a group. It has no independent existence. It exists solely to serve its individual members, and has no other reason for being.

A Parabarb's culture is a social machine, just as his car is a transportation machine. A man may acquire considerable affection for a car he likes, but he doesn't owe it loyalty unto death. When it starts giving more trouble than he feels it's worth, he's unlikely to feel many qualms about trading it in on another one. Similarly, to a Parabarb, a smoothly functioning culture is well worth service and maintenance, but once it gets too screwed up to be worth fixing . . . scrap it and build a new one.

To a patriotic Citizen, a Parabarb is an ungrateful monster with no respect for the law and no loyalty to his country. "America—love it or leave it!" expresses this perfectly. That makes as much sense

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to a Parabarb as "Your car—love it or walk!" No sane entity owes deathless loyalty to a machine, by divine right. And that's all a Parabarb sees in any culture: a social machine.

To a Citizen, a Parabarb looks just as lawless as a Barbarian. Neither feels morally obligated to obey the laws of society. Both choose to obey or not on a personal advantage basis, to which the Parabarb adds his judgment of the rights or wrongs of the law. The true Citizen considers neither. He obeys a law because it's The Law. He accepts military conscription as his duty—a duty neither Barbarian nor Parabarb acknowledges. In demanding that *he* serve *it*, the Parabarb sees the culture as violating its reason for being. The machine is trying to stuff its operator into the fuel tank, which no sane entity will permit.

Barbarian or Parabarb may enlist for their own personal advantage. Or a Parabarb may enlist for a *real* need (such as to repel a foreign invasion). But he will never accept induction out of duty. He owes no duty. The government exists only to serve the people, it has no right to demand service in return. All the people owe is a reasonable amount of maintenance on the social machine. "Patriotism" is simply a meaningless noise.

The Citizen dutifully pays all taxes. The Barbarian pays those he can't avoid. The Parabarb pays those he can't avoid, plus those he feels are justified. (Governments understand this; that's why opportunities for tax evasion are so carefully limited.) Nor will Barbarian or Parabarb feel guilt for "cheating the government" on whatever taxes they evade.

"Cheating the government," in fact, is meaningful only to a Citizen. No Citizen will collect welfare while earning money elsewhere . . . he's no longer a Citizen if he does (as the Tribesman who resents orders is no longer a Tribesman). A Barbarian will jump at the chance of getting a good thing. So will a Parabarb, because in getting all he can from the system, he's merely using the social machine for its intended purpose.

Voting is another vital matter. Citizens vote dutifully. Barbarians and Parabarbs don't, because they know their individual votes have no power. With only Citizens (and some Tribesmen) voting, the vote is sure to give a false picture of "the will of the people," particularly on matters involving individual rights versus government power. That's partly why libertarian republics evolve into police states. Convince the Citizens that society needs restriction of personal freedom, while the Barbarians and Parabarbs, whose *aggregate* vote might reverse the trend, don't vote because their *individual* votes have no power. Only getting them to vote can halt this. Admittedly, individual votes will never have any power, but the

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total Barbarian/Parabarb vote definitely would.

Neither Barbarian nor Parabarb has a sense of Civic Duty to appeal to. Making it to the voter's immediate personal advantage, though, would work. In short, pay each registered voter for his vote. At twenty dollars for a major election, this would cost three gigabucks for a hundred and fifty million voters, which seems a lot. However, it'd be only every couple of years. It's also less than a tenth of what's being spent annually in Vietnam . . . which, nowadays, most people feel is pure waste.

It should be obvious who the Parabarbs are. What do Citizens call the various campus radicals, hippies, and "underground" elements? "Barbarians!" "No respect for law and order!" "No patriotism!" "No love for their country!" "No social responsibility!" These, friends, are the exact charges a true Citizen will hurl at the Parabarbs. Consider what these "revolutionary" elements are actually saying and doing, and it becomes clear that their true nature is largely Parabarb.

This is a hopeful sign. Previously, cultures that started evolving toward totalitarianism continued until the Barbarian and some Citizen elements smashed them. However, a civil culture containing Parabarbs can no more remain civil than a Barbarian culture containing Citizens can remain barbaric. This seems to be happening. Many Americans, raised under the Citizen orientation, have switched and are switching over to being Parabarbs. A Parabarb culture cannot become totalitarian, for the philosophy of the absolute totalitarian state is diametrically opposed to the concept that the culture exists only to serve its members. If we are seeing true Parabarbs among us, the trend toward totalitarianism in this country will be reversed. There are some signs that the process is beginning.

Peacefully? Hopefully, yes. Citizens are fanatically loyal to their culture . . . but Barbarians have no use for the culture whatsoever. When Barbarians smash a culture, they *smash* it. Parabarbs are more pragmatic. They will tear down no more than they must to rebuild the thing. There are no used culture lots to see for a later model, and no one with sense scraps a running car if that means he'll have to walk. Parabarb "revolutionaries" will always try to rebuild a working culture ("change within the system") rather than destroy it and start over from scratch. Only where the trend toward totalitarianism has gone too far, the matrix become too rigid to mold, will they destroy the existing system entirely.

I don't believe the U.S. has reached that point of no return yet. But only time and history will prove me right or wrong. ■

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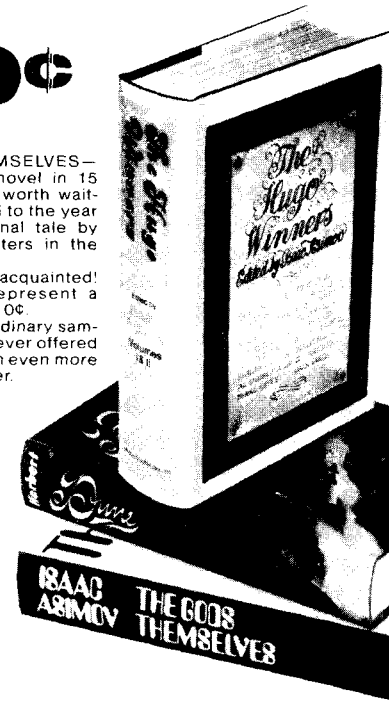

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